Wartime Air Traffic Control

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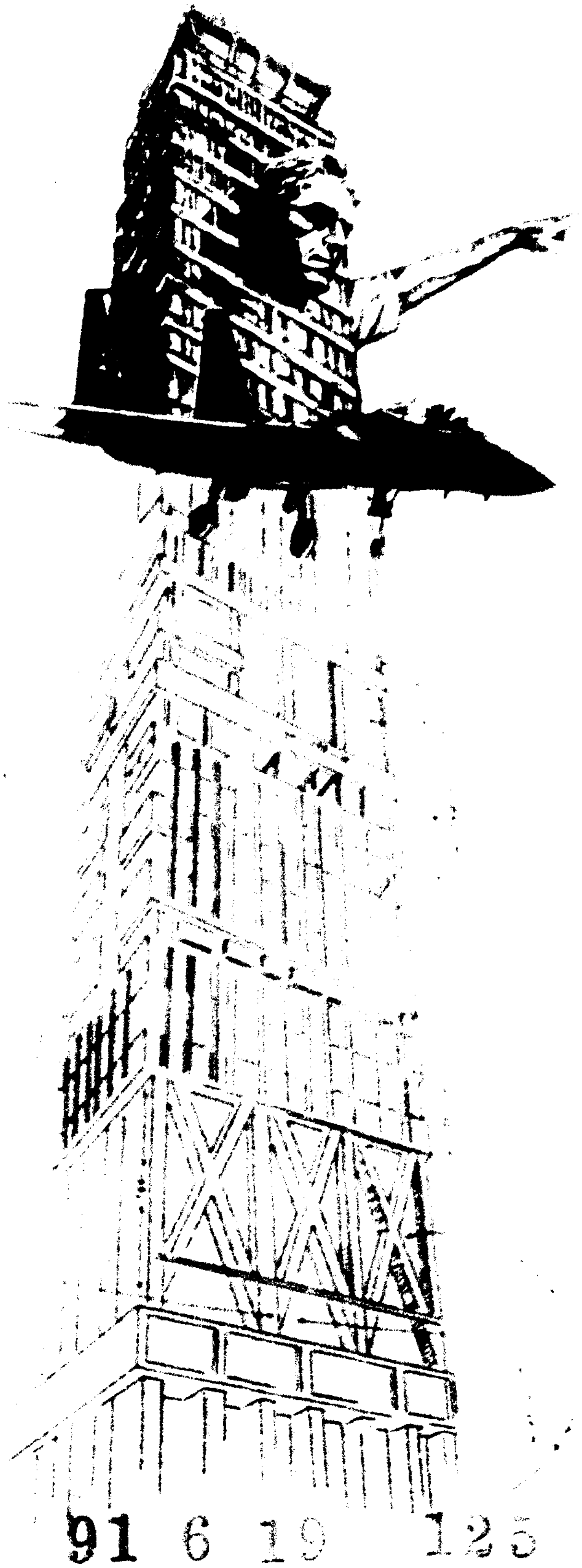
Pamela A. Hamilton-Powell, Maj, USAF



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Wartime Air Traffic Control

Hamilton-Powell

Thank you for your assistance

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Wartime Air Traffic Control

by

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Contents

Foreword

Shrinking military budgets, which appear inevitable over the next few years, make it essential that defense resources be used productively. Such productivity requires a constant focus on war-fighting capability. Marine Corps Fleet Marine Force Manual (FMFM) 1, *Warfighting*, states succinctly: "There are two basic military functions: waging war and preparing for war. Any military activities that do not contribute to the conduct of a present war are justifiable only if they contribute to preparedness for a possible future one."

Support functions must be evaluated in terms of their contribution to this bottom line. In these austere budget times, the Air Force needs to look at such support functions as air traffic control (ATC) in terms of "value added" to war-fighting capability. Functions that do not enhance combat power are potential candidates for civilianization. At first glance, military ATC might seem a lucrative target. After all, the Federal Aviation Administration (FAA) already handles the bulk of ATC in the United States, and countries where we have (or may have) forces deployed operate their own ATC systems. To responsibly answer the question: Why not civilianize USAF ATC?—we must clearly understand the contributions a military ATC system makes to combat capability and how ATC supports air base operability (ABO) objectives.

Maj Pamela A. Hamilton-Powell's research project began as an effort to define the wartime mission of air traffic control. Some of us were skeptical at first. It seemed "intuitively obvious" that ATC directly supports war fighting. However, it quickly became apparent that such a role is not universally recognized. Major Hamilton-Powell's early attempts to obtain information from major command-level senior pilots demonstrated that those senior operators have no clear, consistent vision of what they expect ATC to do for them in wartime. Equally worrisome, many controllers think of themselves first as air traffic controllers—not as war fighters. Finally, ABO planners often fail to grasp the breadth of support ATC can provide to meet air base operability objectives. As these gaps became obvious, Major Hamilton-Powell's research evolved toward a "big picture" view of how ATC supports ABO, with splashes of history thrown in for perspective. She has included a number of recommendations, some controversial and some merely common sense, which should lead to a more effective integration of ATC into ABO planning. Most significantly, she has reviewed a complex

subject and tailored her remarks for a diverse audience consisting of controllers, pilots, and ABO planners. The result is a well-balanced look at the wartime role of air traffic services.

DENNIS M. DREW, Col, USAF
Director
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About the Author

Maj Pamela A. Hamilton-Powell

Maj Pamela A. Hamilton-Powell is currently stationed at Headquarters Federal Aviation Administration in Washington, D.C., as a liaison officer. She completed this study while assigned as the Air Force Communications Command-sponsored research fellow for 1989–90 at the Airpower Research Institute of the Air University Center for Aerospace Doctrine, Research, and Education (AUCADRE), Maxwell AFB, Alabama.

Major Hamilton-Powell is a 1976 Reserve Officer Training Corps graduate of the University of New Hampshire. In addition to an undergraduate degree in mathematics, she holds a master of aviation management degree from Embry-Riddle Aeronautical University in Florida and is a resident graduate of the Squadron Officer School and Air Command and Staff College. She is a senior air traffic control officer who has been assigned at both unit and major command levels, and she also has served a tour with the AFCC inspector general team. Her military decorations include four Meritorious Service Medals and the Air Force Commendation Medal. Major Hamilton-Powell is married to Maj Gary D. Powell, a fellow air traffic control officer.

Preface and Acknowledgments

Having spent the last 14 years of my life involved, in one capacity or another, with the Air Force air traffic control (ATC) system, I have been amazed by the number of people (both inside and outside the ATC community) who equate military controllers with Federal Aviation Administration (FAA) controllers. Obviously there are similarities. Military controllers receive FAA certifications and apply FAA rules and procedures. Some even work for the FAA after they leave the service. Yet, the bottom line is that as long as we wear Air Force uniforms (be they blue or battle dress) we are war fighters. We are not civilian controllers who just happen to wear a uniform—and for that reason our perspective has to be different. We must focus on war-fighting capability. Specifically, we must focus on what we can do to help our air bases defend against an attack, survive an attack when that defense fails, recover quickly, and return to generating combat sorties. Some controllers say, "That's not our job." I disagree vehemently. It is every Air Force member's job. And we, as air traffic controllers, are in an ideal position to provide support through the entire spectrum of air base operability (ABO) objectives.

As I began this project, I realized that any discussion of the wartime mission of ATC had the potential of escalating into a 300-page document that my intended audience would be reluctant to read. I have tried to avoid that trap by ruthlessly limiting my topic and by focusing on the "big picture." Since I hope this report will be read by pilots and ABO planners as well as controllers, I have tried to avoid ATC jargon and to explain clearly how the ATC system works and how it interfaces with the tactical air control system (TACS), base defenses, and theater war planning. My hope is that this paper is comprehensible to a noncontroller. At the same time, since I recognize that the bulk of my audience will inevitably be air traffic controllers, I have attempted to tailor the report to be useful to a new ATC officer during initial upgrade training and early assignments. My goal throughout has been to produce a document that will serve as a primer for those individuals less experienced in air base operability and less aware of the role ATC can play in support of ABO objectives.

This year has been a tremendous challenge. While I was facing the difficulties of balancing my research responsibilities with Air Command and Staff College (ACSC) obligations, the world kept shifting out of focus. As walls fell throughout Eastern Europe, the Soviet threat appeared less malevolent and congressional members clamored for a "peace dividend." Who could have anticipated, at the start of this project in June 1989, the profound changes in our world that would occur before I completed my

second chapter? As I reflected on whether this project still had any value, I was privileged to listen to some of our foremost military leaders expound from the ACSC stage on the changing threat and on force structure requirements for the twenty-first century. It quickly became apparent that even flag officers do not have crystal balls and are not sure what will happen during the next decade. Yet three intertwined threads ran through those many lectures: (1) We cannot predicate our force structure on Soviet intentions. (2) The Soviets are not the only folks wearing black hats. (3) Although our forces will undoubtedly become smaller, we must remain strong to protect our national interests. All that considered, I remain convinced that military air traffic controllers must maintain (or develop) a war-fighting mind-set. While I have no illusions about changing the attitudes of those who disagree with me, I will count this year a success if my efforts cause people to stop and think about the issues.

From a personal perspective, this year has been an unqualified success. I believe I have grown more as an Air Force officer this year than in any of the past 13. I have been exposed to new ideas, both at AUCADRE and ACSC, which have radically changed the way I think about war fighting. I am grateful to the Air Force Communications Command for allowing me to spend a year completing this research. It has been exciting to have the opportunity to focus on the subtleties of the wartime mission of ATC. It is even more exciting to know that what I believe and write will be published and distributed to ATC managers and ABO planners throughout the Air Force.

I owe a tremendous debt of gratitude to my research advisor, Jerry Klingaman, and my editor, John Jordan. They helped me focus my thoughts, ensured what I wrote was what I wanted to say, and kept me motivated through a long, tough year. Jerry and John were a tremendously supportive team and deserve much of the credit, but none of the blame, for my final product. I also owe sincere thanks to many good friends who provided suggestions, criticism, and encouragement throughout my endeavor. These include Col Mike Ryanczak, Maj Sheryl Atkins, Maj Ron Coleman, and Maj Carol Ludwig. Dozens of other controllers, both at Headquarters AFCC and throughout the command, as well as my ACSC seminar mates, spent hours patiently answering my questions. They were valuable (and much appreciated) sources of ideas, information, and encouragement.

Finally, my deepest love and gratitude go to my husband, Gary, who spent this year on a remote tour at Kunsan AB, South Korea, but provided long distance support and encouragement through letters and telephone calls. While I missed him tremendously, his absence allowed me to focus on ACSC and my research project without the distractions of having to

maintain a family life, too. I would not want to repeat this year, but as it comes to an end I have to admit that it has been tremendously challenging and rewarding.

PAMELA A. HAMILTON-POWELL, Maj, USAF
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Introduction

The debate over whether air bases are survivable continues to rage throughout the Air Force. Some optimists still believe our air bases are invulnerable sanctuaries that will be protected by an inevitable USAF air supremacy. However, an increasingly popular school of thought contends that air supremacy is unlikely in a future conflict and, just as we would prefer to destroy an enemy's air force on the ground, the Soviets have come to the same conclusion.[1] Reinforcing that ominous thought, "Soviet weapon systems [now] have improved in range, accuracy, and lethality to the point where they can strike and seriously damage our theater air bases."[2] Likewise, a proliferation of sophisticated weaponry throughout the third world now puts that capability within the grasp of other potential adversaries.

Air base operability (ABO) is the four-pillar Air Force program designed to reduce air base vulnerability by defending against an attack, minimizing the effects of an attack, recovering after the attack, and resuming generation of combat sorties.[3] ABO has evolved from fragmented earlier programs (i.e., air base defense and air base survivability) into a systems approach intended to correct a widely perceived deficiency. ABO planners are responsible for developing integrated initiatives that will provide a balanced capability to enable an air base to deter or survive an attack and continue to generate combat sorties.

There are many interlocking combat support components of ABO. One of those, air traffic control (ATC), is a critical factor in the effort to launch and recover aircraft, and it also plays a role in air base defense. Therefore, survivability of an ATC capability must be one of the goals for ABO planners. This paper addresses the wartime role of air traffic services and establishes the importance of integrating ATC considerations into the ABO planning process.

Road Map

This research project is divided into four separate but related areas: basic concepts, operational factors, equipment factors, and recommendations. It begins by going "back to basics." The first chapter creates a baseline by defining key concepts used throughout the paper. The second addresses the question of which operational factors create an effective, responsive military ATC system for a future combat environment. A closely related question, examined in the third chapter, is whether current and

programmed ATC equipment resources mesh with those operational requirements. The concluding chapter provides recommendations based on the preceding narrative.

Limitations

To restrict this research project to a manageable size, the author had to establish several project limitations and make some key assumptions. First, since the paper's primary focus is on the defend, survive, recover, and generate roles of ATC before, during, and after air base attacks and since the Air Force generally assumes attacks on air bases are most likely to occur in overseas areas, the research is restricted to ATC/ABO issues overseas. An additional reason for this limitation is that the military ATC system in the continental United States (CONUS) is tightly entwined with the Federal Aviation Administration (FAA) system. Although there is an extensive "blue-suit" ATC mission within the United States, in theory the FAA could take over responsibility for all CONUS ATC with minimal effect on the military flying mission. The FAA already provides primary ATC service for a number of Air Force bases. A massive upgrade of the nation's ATC system, scheduled for the 1990s, will further decrease dependence on military ATC within CONUS by realigning missions, consolidating facilities, and establishing some joint FAA/military facilities.[3] Thus, although CONUS military ATC facilities obviously perform a vital function by providing a military controller training capability for the Air Force's war-fighting mission, this paper assumes that the primary military ATC mission is overseas (to include Alaska).

Second, this paper assumes the Air Force would need to provide its own ATC resources during an overseas conflict. Although "the political constraints and existing ATC structure of the host nation . . . provide the framework around which tactical air operations will be planned," the Air Force already has fixed ATC systems in use at main operating bases in Germany, Great Britain, Spain, Italy, Belgium, Japan, Okinawa, South Korea, and the Philippines.[4] These systems would surely be needed during a conflict in any of those areas.

Although some allies, such as Japan and Germany, have highly sophisticated civil ATC equipment as well as well-trained controllers and could theoretically take over the military ATC mission, it is questionable whether they could—without extensive training in aircraft surge, launch, and recovery (ASLAR) procedures—handle wartime military requirements. Other allies, such as the Republic of Korea, have not yet built their civil ATC system to a point where they could even attempt to take over the responsibilities currently handled by US military controllers. In short, it seems reasonable that, at a minimum, the US military ATC systems already in place overseas would continue to operate during a conflict. In fact, it seems

even more likely that additional ATC support would be needed as the conflict progressed and that additional airspace and responsibility would be delegated to existing US ATC facilities.

Third, although the ATC system in wartime is the tactical air traffic control element (TATCE) of the tactical air control system (TACS) and is part of the airspace control structure, this research is restricted primarily to an analysis of ATC in the terminal environment.[5] Discussion concentrates on "traditional" support to aircraft launch and recovery. The second chapter does discuss the ATC/TACS interface and airspace control, but that discussion is limited to general relationships.

Fourth, Air National Guard (ANG) and sister-service ATC systems are not considered. The ANG, Army, Navy, and Marine Corps all have ATC resources to support wartime operations. The ANG maintains a significant portion of the Air Force's tactical ATC capability in its combat communications units. Navy controllers provide carrier-based ATC service as well as service from fixed ATC facilities at naval air stations. Army controllers operate a "network of flight operations centers, flight coordination centers, approach/departure control facilities, airfield control towers, and navigational aids . . . for the control and coordination of Army air traffic."[6] Marine controllers deploy with a Marine air-ground task force to support the aviation combat element, and they operate fixed ATC facilities at Marine Corps air stations.

Although service responsibilities might at first glance appear extremely parochial, the reality is not that simple. Army, Navy, and Marine Corps aviators routinely land at Air Force bases after coordinating with Air Force controllers. Air Force pilots may land at a Navy or Marine air station or at an Army bare-base landing strip. These military ATC elements mesh to provide a support network that is integrated by the designated airspace control authority (normally the air component commander) into a theater-wide ATC system.[7] The author acknowledges the Army, Navy, Marine, and ANG contributions to a wartime ATC system but, for purposes of simplicity, this paper focuses solely on the Air Force portion of the system.

Fifth, while this paper devotes considerable space to discussion of ATC equipment, it is restricted to basic equipment capabilities and functions. The author does not distinguish between successive generations of equipment, nor does she address the many support equipment components and automation features that enhance today's ATC system. And, although the author recognizes that some sophisticated internal aircraft systems (e.g., inertial navigation systems and cockpit radar systems) augment and enhance traditional ATC, she focuses solely on external systems that support terminal ATC operations and en route navigation. Likewise, discussions of ATC procedures (both peacetime and wartime) are simplified. The author's intent is to leave readers with a sound understanding of the concepts

underlying the Air Force's ATC system and a vision of how the pieces fit together.

Sixth, this paper does not consider such associated missions as combat flight inspection, standardization and evaluation, or the air traffic system analysis program. Although these functions are essential to ensure that the entire ATC system (equipment and controllers) is operating within allowable parameters and at peak efficiency, they are not central to the ATC mission itself.

Finally, this paper ignores, for the most part, theater differences. There are significant differences between the Air Force ATC roles in Europe and the Pacific, as well as in potential roles in Latin America or the Middle East. Theater variations—which are driven by operator requirements, host-nation restrictions, and the existing infrastructure—are important, but various constraints precluded an effort to address all theaters adequately. Most of the information this paper provides is general and applies, with some tailoring, to any theater or situation. Most examples, however, come from one theater—the Pacific.

Notes

1. Col V. Alekseyev, "'Conventional' Wars and Ways of Waging Them," *Krasnaya zvezda*, 4 October 1986, 5, in *Soviet Press Selected Translations*, n.d., 90, *Current News Special Edition*, 30 June 1987, 90.
2. Maj Gen George E. Ellis, "More Hands for Base Defense," *Air Force Magazine*, December 1988, 68.
3. Federal Aviation Administration, "National Airspace System Plan," September 1989, n.p.
4. Air Force Manual 2-12, *Airspace Control in the Combat Zone*, 22 August 1988, para. 2-4d.
5. Ibid., para. 2-5i.
6. AFM 2-14/FM 100-42, *US Air Force/US Army Airspace Management in an Area of Operations*, 1 November 1976, para. 3-3c.
7. AFM 2-12, paras. 2-1c and 2-3c.

Chapter 1

Basic Concepts

Since the intended audience for this paper is quite diverse, this chapter establishes a baseline by introducing key concepts and defining terms central to the following chapters. The chapter is divided into two major subsections: air traffic control (ATC) and air base operability (ABO). The first section begins by providing some historical background for the military ATC system. It then discusses the current structure of the Air Force system and the future utility of that system. Likewise, the second section discusses ABO's past, present, and future. The chapter concludes with a short discussion of the relationship between ATC and ABO.

Air Traffic Control

Air traffic control service is defined in Joint Publication 1-02, *Department of Defense Dictionary of Military and Associated Terms*, as: "A service provided for the purpose of . . . preventing collisions . . . between aircraft, . . . between aircraft and obstructions, and . . . expediting and maintaining an orderly flow of air traffic."[1] Although those familiar with today's highly automated and complex ATC equipment may believe ATC is an innovation of the "video age," it has actually been around in simpler forms for more than half a century. To understand the future wartime mission of ATC, it is necessary to first look at how the system evolved.

History

Air traffic control in the US military traces its roots to July 1914 when "House of Representatives Bill 5304 assigned the Aviation Section of the United States Army Signal Corps . . . 'the duty of . . . supervising the operation of all military aircraft, including balloons and aeroplanes, all appliances pertaining to said craft, and signaling apparatus of any kind when installed on said craft.'"[2] In the early 1920s, the Army Air Corps established an aerial transportation route with major stations at Bolling Field, District of Columbia; Langley Field, Virginia; McCook Field, Ohio; Mitchel Field, New York; Chanute Field, Illinois; Selfridge Field, Michigan; and Wright Field, Ohio.[3] "Radio stations were established at the seven major stations, but [were] not operated as a 'system.' Each airfield and the communications provided were the responsibility of the local commander."[4]

The resulting gaps in coverage were further exacerbated by pilot reluctance to use the new radio procedures.

> Until the mid-1930s . . . radio reception was difficult, if at times not entirely impossible, because of engine ignition interference. Moreover, the complex wiring for receivers and transmitters often caused fires in the aircraft [and] early radio sets weighed so much that the payload and fuel load had to be reduced when radios were carried. As a result, many pilots developed an antipathy to radios so violent that many of them tossed sets overboard and reported their accidental loss.[5]

Fortunately, such aviation pioneers as Lt Col Henry H. ("Hap") Arnold and Capt Harold M. McClelland recognized the need for an integrated system of adequate ground-air-ground communication.[6] A turning point came in the summer of 1934 when 10 B-10 bombers, led by Arnold, "flew a distance of 8,290 miles from Bolling Field, Washington, D.C., to Alaska without mishap. . . . The flight was never out of contact with communications systems on the ground [and] information on weather and local conditions was continuously available."[7] Shortly after that epic flight, Arnold and a group of other aviation pioneers met in Washington, D.C., to discuss a future architecture for airways communications.[8] They agreed that an effective system should include four elements:

> 1) Alerted Point-to-Point—radio stations at airfields would remain continuously aware of planes in flight and would be free from interference by other traffic such as long administrative messages or attention to other duties; 2) Air/Ground and Ground/Air—uninterrupted contact ensuring emergency attention when needed; 3) Navigational Aid—by means of radio beacons, compasses, and transmission of regular weather information; 4) Traffic Control—at airfields for both takeoff and landing.[9]

Yet, it was not until 1937 that a War Department subcommittee on communications chaired by Lt Col Robert Olds published a report (commonly referred to as the Olds Report) that "recommended establishment of an 'Army Airways Control System' comprised of meteorological, airways, and airdrome control within the continental United States (CONUS) and in overseas possessions."[10] A year later,

> Headquarters Army Air Corps established the Army Airways Communications System (AACS). The primary mission of AACS was to provide air-ground and ground-air communications between [airborne aircraft and] AACS aeronautical stations in the continental United States to promote safety and to facilitate flying operations. The secondary mission was to provide point-to-point communications between ground radio stations in the continental United States. These stations transmitted aircraft movement reports, weather reports, and messages relating to Army airways traffic between ground stations. Air traffic control was added as an AACS mission in 1939.[11]

During the next 50 years, basic ATC responsibilities remained essentially the same, although the equipment available to accomplish the ATC mission became increasingly sophisticated. Perhaps the most revolutionary change involved the invention of radar. (Radar is an acronym for radio detection and ranging.) In simple terms, a radar transmitter creates radio waves that are emitted by its antenna as short, powerful pulses of radio energy. These waves are reflected as echoes from objects located within the antenna's field of vision. The time a reflected wave takes to return indicates how far away

the object is (i.e., its range). The direction from which it returns reveals the object's location. The reflected waves are enhanced by a receiver so the object's range and bearing from the radar set can be depicted visually on a radar display.[12]

In the 1920s and 1930s, American, British, and German teams working along parallel lines began experimenting with radar. Although the Americans and Germans were not far behind, the British team led by Sir Robert Watson-Watt was the first to field an air defense radar system. The system was tested successfully against Royal Air Force aircraft in 1937. Immediately following that test, the British began constructing a chain of radar sites to protect their eastern and southern coasts.[13] "Just before the Battle of Britain [August 1940], the British had 57 radar stations—many with standby and supplementary mobile equipment—in an uninterrupted watch over the British Isles."[14]

When the Germans launched waves of bombers against England, those radar systems provided a decisive edge. The British ability to launch fighters in response to radar warnings resulted in heavy German losses. When the Battle of Britain ended, 602 attacking German aircraft had been destroyed as compared to 259 British losses. Concluding that the costs of trying to slip through the British radar network were too high, the Germans turned their attention to other military targets.[15]

Once the Battle of Britain convincingly demonstrated the value of radar as a defensive measure, other uses rapidly became apparent. Military applications of radar quickly expanded to include such functions as air traffic control. In fact, the US Army Air Corps employed its first radar system, known as ground control approach (GCA) radar, in Great Britain in the spring of 1944. The system was revolutionary because it enabled controllers to "sight" an approaching aircraft 30 miles away from an airport and

> instruct the pilot in the proper speed, altitude, and direction needed to stay on the correct glide path to the runway for a safe landing when either darkness or weather conditions prevented the pilot from seeing the runway. It was an economical system, not only in the lives and aircraft it saved, but because the aircraft required no special equipment and the pilot needed no special training. Its inventor, Dr Luis W. Alvarez, was presented the coveted Collier Trophy by President Harry S Truman in 1946. The Collier award selection committee called ground controlled approach radar "the greatest achievement in aviation in America."[16]

One limitation of the early radar systems quickly became apparent, however. As Sir Robert Watson-Watt pointed out, "It is of little value to know there is an aircraft out there unless we know whether it is friend or foe."[17] One might argue that "friendlies" would respond to radio communications from controllers asking for identification, ergo any aircraft failing to respond must be hostile. That is a dangerous assumption, as any pilot who has experienced radio failure before returning to base would attest. This limitation was addressed in the 1950s with the introduction of the air traffic control radar beacon system—also known as secondary

radar.[18] (The functions of primary and secondary radar are discussed later in this chapter.)

Combined with standard radar identification procedures, secondary radar made it possible for controllers to identify aircraft in the controllers' areas of responsibility without transmissions from the pilots. Not a foolproof system, certainly, but more reliable than depending solely on primary radar targets and two-way, pilot-controller communications. With the development of secondary radar, controllers had the basic tools they would need to support peacetime and combat air operations through the next three decades.

Current System

Today, Air Force Communications Command (AFCC)—the successor to AACS—is responsible for the Air Force air traffic control mission. AFCC's deputy chief of staff for air traffic services is the Air Force's executive agent for the free world's largest military ATC system. In that capacity, the deputy chief oversees operations of approximately 120 control towers and more than 80 radar facilities worldwide.[19] At the base level, ATC service is provided by enlisted air traffic controllers assigned to communications squadrons or groups. One or two company-grade officers, a chief of air traffic control operations (CATCO), and, perhaps, a deputy CATCO normally supervise operations, although a field-grade officer may be assigned as the CATCO for more complex operations. US peacetime control procedures are highly standardized and prescribed by the Federal Aviation Administration (FAA).

Beyond these general characteristics, base ATC systems vary widely in individual components and responsibilities. For purposes of this research, a "generic" ATC system consists of a control tower, a radar system (composed of an operations center, a surveillance radar, and a precision approach radar), a tactical air navigation (TACAN) system, an instrument landing system (ILS), ultrahigh frequency (UHF) and very high frequency (VHF) radios, air traffic controllers, a set of established ATC procedures (including both peacetime and wartime procedures), and some amount of airspace delegated for USAF ATC operations. The following paragraphs briefly describe radar, control tower, TACAN, ILS, and controller functions.

Radar Operations. The ground control approach radar of World War II has evolved into the two basic types of military ATC radar systems in use today. *Airport surveillance radar* uses an antenna that rotates 360 degrees. As the beam sweeps, it scans for objects in all directions out to a distance of approximately 60 miles. Aircraft within that range are depicted on a controller's radar scope as bright spots. These targets are known as primary or "raw" radar targets. The locations of targets on the scope allow the controller to determine each target's bearing and distance from the radar set. A secondary radar antenna operates in concert with the primary radar by sending out an interrogation signal to the onboard transponders

of aircraft within its range.[20] These transponders reply with a group of coded pulses.[21] When the pulses are decoded and displayed on a radar scope, they consist of—at a minimum—a secondary radar target, a four digit aircraft code or "squawk," and aircraft altitude. Using the primary radar targets and the secondary radar information, radar controllers provide heading and altitude directions to landing and departing aircraft and deconflict traffic within their assigned control area.

Precision approach radar (PAR), the second basic type of radar system, is only concerned with a narrow corridor along the final approach course. Two separate antennas scan horizontally and vertically to provide distance, course, and glide-path information.[22] The azimuth antenna, which scans approximately 20 degrees horizontally, provides information that allows controllers to tell pilots how far they are from the runway and how far left or right of the runway centerline. The elevation antenna scans about 8 degrees vertically, allowing controllers to provide advisories as to aircraft position in relation to the glide path. Both types of information are displayed on a single scope, allowing a controller to talk the pilot down the approach course to a precision landing in adverse weather conditions.

Tower Operations. The control tower is probably the first thing to come to mind when someone mentions ATC. Yet, the control tower actually plays a limited—albeit vital—role in the ATC system. Tower controllers can best be thought of as traffic cops working in three dimensions. They are responsible for the airport traffic area (ATA), which is usually the "airspace within a horizontal radius of five statute miles from the geographic center of any airport at which a control tower is operating, extending from the surface up to, but not including, an altitude of 3,000 feet above the elevation of the airport."[23] Pilots are prohibited from entering an ATA until given permission to do so by the control tower. Tower controllers provide airfield advisories as well as clearances for landing and departing aircraft, and they sequence all traffic within the ATA. These responsibilities sound simple, until one considers that some of those aircraft are being controlled by the radar facility.

To understand how tower and radar operations mesh, one must understand the difference between instrument flight rules (IFR) and visual flight rules (VFR) operations. A pilot flying IFR relies on cockpit instruments and heading/altitude instructions from an ATC radar facility to navigate from point to point and to remain safely separated from other aircraft. A pilot flying VFR "relies on his own sight to keep track of his route and on his alertness to avoid other aircraft."[24] IFR procedures can be used whenever the pilot desires, but they are required when weather conditions fall below certain ceiling and visibility minimums.

When weather conditions are above IFR minimums, air traffic in the ATA usually consists of a mix of VFR and IFR traffic. For example, pilots flying visually are operating VFR and talking to tower controllers; pilots making practice instrument approaches are operating IFR and are in voice contact with radar controllers throughout the approach. Two controllers handling

aircraft via different procedures within the same airspace (the ATA) sounds like a recipe for disaster, but the key to success is that the tower controllers are still responsible for "guarding" the ATA. Radar controllers must obtain tower approval before IFR aircraft enter the ATA, and tower controllers then sequence aircraft flying VFR into the landing sequence along with all IFR traffic controlled by the radar facility. These procedures may sound overly complicated, but they work. A system of coordination lights, interfacility hot-line communication, and well-established procedures ensures that IFR and VFR traffic mesh smoothly.

Tactical Air Navigation System. The TACAN system was introduced in 1957 and is still the primary navigation system in use today for en route point-to-point navigation.[25] TACANs are "very high frequency omnirange radio stations that send guidance directions to all degrees of the compass."[26] By homing in on the TACAN for a particular location, pilots can determine their bearing and distance from the airfield and can fly toward that point. Although TACANs are limited to line-of-sight coverage, their signals can be received from as much as 200 miles away.

Instrument Landing System. An ILS provides a precision approach capability similar to that of precision approach radar. An ILS consists of a fixed localizer beam that provides guidance to an airport runway, a fixed glide-path beam that provides guidance during descent, and marker beacons that define an aircraft's position along the approach course.[27] ILS receivers in aircraft indicate deviation—left or right, up or down—from a standard approach course.[28] Like PAR, an ILS is restricted to straight-line approaches; however, a major difference is that ILS does not require pilot-to-controller communication.

Controllers. Everyone who goes to the movies or watches television can visualize air traffic controllers in towers or at ATC radar scopes, and basically understands what controllers do for a living. Controller qualifications and specific responsibilities need not be discussed here, but a few points require clarification. Most AFCC controllers are assigned to fixed (i.e., permanently installed) tower and radar facilities. They generally work either tower or radar operations—but not both. Although AFCC emphasizes maintaining a cadre of dual-qualified controllers at each base, training realities make it virtually impossible for all controllers to be both tower and radar rated. Controllers complete an extensive local training program wherever they are assigned, and a previously qualified controller may need six to nine months training (or longer) to earn a "facility rating" at a new base. Thus, requiring each controller to earn both a tower and radar rating is not feasible. This point is significant because a lack of dual-qualified controllers can limit an ATC manager's flexibility during contingency or wartime situations.

In addition to the command's fixed ATC systems at CONUS and overseas bases, five AFCC combat communications groups (three in CONUS, one in Europe, and one in the Pacific) provide tactical ATC service when and where it is needed.[29] One of the missions for these units is restoring ATC service.

Controllers and maintenance technicians deploy, along with mobile control towers, radar approach controls, and TACANs, to bases where fixed ATC equipment has been damaged or destroyed. Combat communications groups can provide additional personnel to augment the controller force or to replace casualties at main operating bases, and controllers can deploy along with their mobile ATC equipment to a bare base. Although combat communications units deploy routinely for exercises and training missions or to provide ATC support during upgrades of fixed ATC equipment, it is important to remember that their primary mission is combat support. Two recent military operations gave them the opportunity to test their capabilities. In 1983 the 2d Combat Communications Group from Patrick AFB, Florida, deployed controllers and equipment into Grenada in support of Operation Urgent Fury. In 1989 the 3d Combat Communications Group from Tinker AFB, Oklahoma, deployed to Panama in support of Operation Just Cause.

One final point of clarification may be helpful. Many people confuse combat controllers with air traffic controllers. After all, it seems logical that controllers assigned to combat communications groups would be called combat controllers. Not so: they are simply air traffic controllers, as are their brothers and sisters who man fixed ATC facilities.

Combat controllers are a totally separate group. They do provide ATC service, but they are assigned to Military Airlift Command (MAC) special operations units. Combat controller teams provide "airspace control services at remote assault zones. [They] deploy . . . clandestinely ahead of main assault force, . . . and provide . . . en route or terminal navigation aids" as well as basic landing and departure services.[30] Combat controllers are among the first personnel to arrive at a bare base or assault zone. They deploy to these forward operating locations (often via parachute) to establish landing and drop zones and to provide ATC service for future air operations.[31] Although combat controllers attend the basic controllers' course alongside AFCC's air traffic controllers, their career paths diverge once the preliminary course is completed. Combat controllers attend specialized training including scuba diving, parachutist, combat survival, and water survival courses. At the conclusion of their training, they receive a unique Air Force specialty code.[32]

Historically, there has been little integration of the two groups of controllers beyond their initial training. Combat controllers are not assigned to AFCC's ATC facilities nor are AFCC's controllers assigned to combat controller duty. However, a 1988 agreement between the 4th Combat Communications Group at Yokota Air Base (AB), Japan, and then Detachment 2 of the 1723d Combat Control Squadron at Clark AB, Republic of the Philippines, resulted in some joint training between the two groups and a better understanding of each other's responsibilities and capabilities.[33] Such an appreciation of mutual capabilities is important in a wartime or contingency situation because, "if a long-term operation is [required], the combat control team may be replaced by combat communications [control-

lers], navigation aids, and ATC facilities."[34] Although this paper does not specifically address the combat controller career field, some of its findings and recommendations may be of interest to that group.

Future--Force Multiplier?

Pilots are familiar with, and often grumble about, ATC-imposed airspace and flying restrictions in a peacetime environment. Many like to think that in this age of supersophisticated jets and state-of-the-art navigational aids all controls would be lifted in wartime, and ATC would be a "nonplayer." However, according to a recent Air Staff letter:

> Airspace/Air traffic control systems are vital force multipliers and integral components of the command and control system during combat. They provide airspace deconfliction in the combat zone; launch, separation and recovery of aircraft; and base defense/surveillance, and reporting. . . . These functions enhance combat effectiveness by promoting the safe, flexible use of airspace.[35]

In short, the base ATC system provides critical, direct support for the air base flying mission—in peacetime and wartime. Although aircraft can launch and recover without a functioning ATC system, the system adds an element of safety and ensures an orderly and expeditious flow of air traffic. These advantages not only make ATC a key player in the effort to generate and recover combat sorties but also make ATC facilities lucrative targets.

In 1987 Lt Gen Michael J. Dugan, then Headquarters USAF deputy chief of staff for operations, told AFCC's deputy chief of staff for air traffic services that "AFCC needs to put more emphasis on combat."[36] AFCC is making a concerted effort to follow this advice. For example, a May 1988 AFCC briefing—"ATC in the Combat Environment," presented to major command (MAJCOM) deputy chiefs of staff for operations at Constant Vigil XX—discussed the concept of wartime ATC operations, AFCC's perception of operator requirements, base ATC capabilities, and system limitations.[37] Operational readiness inspections have placed additional emphasis on testing ATC survivability in a hostile environment. The AFCC intelligence staff put together an analysis of Soviet ATC capabilities and limitations, which has since been briefed to operators in the Pacific theater.[38] In addition, there has been a surge in staff efforts to define how the ATC system will integrate with the tactical air control system in wartime. All of these efforts are geared toward educating both the operations and combat support communities as to the capabilities of the ATC system as well as the force enhancement role it can play in future conflicts.

Air Base Operability

AFR 360-1, *Air Base Operability Planning and Operations*, defines air base operability as "those measures necessary to integrate the wartime operational requirements of all base functions to defend against, mitigate the effects of, and recover from hostile action. The overall objective of ABO is

to sustain sortie generation capability to continue employment of air power."[39] That overarching objective is broken into four basic objectives: to defend air bases from attack, to survive by minimizing the effects of an attack, to recover quickly and effectively after an attack, and to generate combat sorties.[40] A fifth objective—support—is sometimes used to describe all supporting measures employed to accomplish the "four pillar" objectives.[41] This paper treats the support role as an integral component of each of the four primary objectives rather than as a separate objective.

History

Although the roots of today's ABO can be traced back to the rudimentary air base defense concepts of World War I, the genesis of ABO as an integrated four pillar program actually occurred in the mid-1980s.[42] At least partially as a result of the 1985 Salty Demo exercise at Spangdahlem AB, West Germany, ABO has generated a great deal of interest at senior levels. A highly realistic exercise, Salty Demo simulated repeated attacks on the air base and demonstrated conclusively that "even a fairly moderate Soviet attack could reduce our ability to generate sorties."[43]

The results of Salty Demo were described as "a sobering demonstration of the synergistic chaos that ensues when everything goes wrong at the same time."[44] Salty Demo planners integrated a wide variety of plausible air base attack results, including runway damage, massive casualties, and damage to "aircraft, vehicles, buildings, communications, and power . . . systems."[45] The results stunned both the military and civilian leadership of the Air Force. When the smoke cleared, the final exercise report contained 316 recommendations, encompassing the entire spectrum of ABO objectives. These recommendations were classified as "critical, serious, workaround or enhancement."[46]

As a result of that exercise, Secretary of the Air Force Edward C. Aldridge identified ABO as one of the highest USAF priorities, and he established the position of assistant secretary for readiness support. Aldridge directed Tidal W. McCoy, the new assistant secretary, to resolve the air base problem.[47] A wide variety of programs were initiated or given renewed emphasis in an effort to do that. For example, "network[s] of fixed and mobile radars [were upgraded to] provide low-, medium-, and high-altitude coverage of friendly airspace"; point-defense weapons were upgraded; alternate landing strips were constructed or improved; and critical base facilities were hardened, revetted, or camouflaged.[48] In spite of all this activity, a 1989 Headquarters USAF functional management inspection of ABO identified continuing problems.[49] Funding constraints, which some argue reflected a belief that ABO was not a serious issue and thus did not warrant a high priority in the Air Force budget process, were at least partially to blame for the lack of progress.[50]

Current Status

The underlying assumptions of today's ABO program are that (1) air bases will be attacked, (2) some attackers will get through the base defenses, and (3) critical facilities and resources will be targeted.[51] Therefore, program objectives must be to reduce the weight of an attack, mitigate the effects of an attack, and recover following the attack to continue the war-fighting mission.[52]

Although verbal support for ABO continues, funding for ABO projects has slowed to a trickle. In an 8 May 1990 briefing at the Air Command and Staff College, Col Gary H. Silence, Headquarters Pacific Air Forces (PACAF) director of support operations, contended that the initial funding for ABO programs was premature. Too much money was pumped into the program too soon. Lack of a clear "vision" of ABO objectives, lack of experienced ABO managers, and lack of a base populace which understood the intent behind ABO all contributed to the problem. Consequently, most ABO dollars were funneled toward such "high-ticket" items as equipment acquisition and facilities construction. Few results were seen, and the equipment now ready to field is being canceled for lack of funds.[53]

Although funding shortfalls have slowed progress toward resolving many of the issues Salty Demo identified, efforts to "sell" air base operability are beginning to yield results. Most importantly, there has been a significant attitude shift "in the thinking of leaders and planners. Many [senior leaders] now talk about 'fighting the air base,' a concept that regards the installation as a war-fighting asset akin to a weapon system instead of as incidental real estate."[54] Most Air Force leaders now recognize that our air bases are no longer sanctuaries and are looking seriously at ways to integrate all the components that assure our ability to defend, survive, recover, and generate effective combat sorties. There is a long way to go, but such tools as the ABO regulation, an ABO master plan, base capability acquisition plans, and base-level ABO working groups are in place and guarantee that the program will continue to receive senior-level attention. Despite such attention, ABO will not be a fully successful program until a war-fighting mind-set is firmly entrenched throughout the service.

Air base operability is the responsibility of the entire base populace. All "blue-suiters" must be mentally and physically prepared to fight the air base war. Winston Churchill voiced this sentiment early in World War II in a letter to his air minister, "Every airfield should be a stronghold of fighting air-groundsmen, and not the abode of uniformed civilians in the prime of life protected by detachments of soldiers."[55] Churchill was absolutely right, and his comments are directly applicable to the highly skilled technicians today's Air Force depends on. Many of these technicians still see the air base war as the other guy's problem. They believe only pilots and aircraft maintainers will fight the war, but that is not the case. "Aircraft armed to the gills sitting on the ramp or in shelters don't win battles. They need to be launched and recovered."[56] The (usually unspoken) attitude of many

support personnel, including air traffic controllers, is: "I'm a technical specialist. If there's an air base attack, the Army will protect the base, the fire-fighters will fight fires, the medics will handle injuries, and I'll do my job." This perspective is naive and shortsighted—and "has allowed [many] to comfortably slip into the role of technician or resource manager."[57] Although such a perspective may be marginally acceptable in peacetime, the United States cannot afford a force of technicians during wartime. It will need warriors.

Such a modern-day warrior as Maj Gen George E. ("Jud") Ellis, the Headquarters USAF director of engineering and services, is a strong advocate of the concept that everyone wearing a blue suit will be a fighter in the air base war.[58] To assure launches and recoveries, the entire base populace must be involved in combat support. That support will obviously involve direct support to the launch and recover mission, but it is also going to involve such indirect support as fire fighting, medical "buddy care," and use of basic infantry skills.[59] General Ellis's position is that the Air Force will "need people who can do more than just the specific job they were trained for at tech school."[60] Those warriors supporting the air base war will include administrators, personnel specialists, communicators—and air traffic controllers. In short, ABO depends on "a warrior spirit that needs to permeate the entire air base population and supporting organizations."[61] After all, it matters little how well each technician does his or her specific job if, by the time he or she gets off shift, the enemy is sitting at the base exchange drinking coffee and smoking a cigarette.[62]

Future—Continued Emphasis or Obscurity?

Although ABO has received a great deal of attention in recent years, the current fiscal climate threatens continued progress in the program. Consider the following points. Responsibility for the ABO program was "downloaded" from Headquarters USAF to the tactical air forces (TAF) in March 1990, with Headquarters Tactical Air Command taking the program lead and Headquarters USAF retaining oversight.[63] Constant Demo '91, intended to be a follow-on to Salty Demo '85, was canceled. Constant Demo would have evaluated Air Force progress in resolving the many disconnects and problems identified during Salty Demo. For example, it would have simulated a "steady degradation of [ATC] services to [allow] realistic evaluation of alternate capabilities and aircraft surge, launch, and recovery (ASLAR) procedures."[64] Additionally, it was to provide a testing ground for procedures, system prototypes, and system modifications designed to contribute to an air base's ability to defend, survive, recover, and generate.[65] The Air Staff's Constant Demo team disbanded after completing an after-action report on Constant Demo planning and preparation. There are currently no plans to revive Constant Demo.

Another important element of ABO—the camouflage, concealment, and detection program—was also eliminated in a recent round of budget cuts.

As a result, ABO manpower at the base level will be reduced by as much as one third within the next two years. A final indicator of ABO reverses lies in the amounts of money being managed by MAJCOM ABO shops. In the mid 1980s PACAF was managing ABO programs on an order of magnitude of hundreds of millions of dollars. In 1990 funding for PACAF ABO programs totaled tens of millions.[66]

Despite the growing scarcity of dollars for ABO programs, positive signals remain. The transfer of ABO responsibility to the TAF indicates that ABO is becoming a MAJCOM-driven (rather than an Air Staff-directed) program.[67] Tailoring the program to better support MAJCOM-specific requirements should result in more creative solutions to problems and more efficient use of scarce funding resources.

A joint TAF and MAC team, consisting of both ABO planners and operators, has recently drafted the first ABO doctrine and is rewriting the ABO regulation to better reflect today's realities. An ABO officer training course is being established to resolve the perennial problem of inexperienced base-level ABO managers.[68] New emphasis is also being placed on ABO's role as an "integrating function."[69] That change in emphasis clearly signifies that ABO planners are not responsible for driving each individual program that will support ABO objectives. Rather, they are responsible for integrating programs that will, in sum, create the balanced capability required by wing commanders to accomplish their combat missions.

Some contend that, as the ABO juggernaut becomes leaner, it is refocusing to better support war-fighting commanders.[70] There is also an effort under way to shift the focus of ABO away from acquisition and toward training.[71] Current thinking is that a great deal can be done to enhance ABO capability without developing newer, more sophisticated systems. As asserted earlier, the key to a successful ABO program is developing a war-fighting mind-set. And the key to that lies in training.

Senior ABO managers believe that the progress made in ABO over the past few years must not be reversed as tough budget decisions are made.[72] Regardless of the continuing changes in Europe and congressional demands for a "peace dividend," there remains a valid requirement for an ABO program. Even if one believes the Soviet Union and the Warsaw Pact are no longer threats to our forces, the bottom line remains the same. The Air Force will have to protect air bases regardless of whom its potential adversaries are. For example, because third-world nations are increasingly obtaining sophisticated, long-range weaponry and enhancing their war-fighting capabilities, the threat to our bases continues. Some skeptics may dismiss that danger by arguing that as long as our opponent is not the Soviet Union our air superiority will be assured. Perhaps, but air superiority does not equate to air supremacy, and even a 10-percent rate of enemy success could do extensive damage to a base's war-fighting capability. The skeptics also do not take into account the possibility of a

terrorist nation's surprise attack against one of our overseas bases. Granted, our intelligence assets probably make that an unlikely scenario; however, many would argue that it is not totally implausible. Even a single terrorist attack could significantly damage aircraft generation capacity. To ensure sortie generation, the air base's defend, survive, and recover capabilities *must* remain intact.

Air Traffic Control—Component of Air Base Operability

Simply put, the ATC wartime mission is to provide support "to launch and recover combat flying operations in all environments."[73] That mission is so closely related to the ultimate goal of air base operability that it seems obvious air traffic control must be fully integrated into the ABO planning process. In fact, the Air Staff position on ABO requirements is that "*anything* [needed] to defend, survive, recover, generate or support [a] combat base because of enemy attacks is an ABO requirement" (emphasis added).[74]

Although it is readily apparent that the ATC system directly supports the sortie-generation pillar, it may be less obvious that the system plays a supporting role across the entire spectrum of ABO. A combination of well-trained controllers and capable, survivable ATC equipment can help defend the air base, survive an airfield attack, recover quickly, and support subsequent launches and recoveries of combat sorties. Thus ATC is one of the myriad of combat support components that must be incorporated into ABO planning. However, the author believes ATC is often overlooked in the ABO planning process and can be better integrated.

At the policy level, there *is* recognition of the importance of ATC to an installationwide, integrated ABO effort. A draft version of a revised AFR 360-1 provides specific guidance concerning protection of overseas ATC facilities:

> ATC facilities, to the extent possible, should be [semihardened] and those not [semihardened] must be given splinter protection (revetment, earthen berms, or sand-filled containers). As a minimum, the ATC Operations Center, TACAN, and UHF/VHF facilities must be protected. Antennas and shelters which cannot be protected must be toned-down or camouflaged. Back-up power facilities and on-site fuel supplies for these facilities must be splinter protected as well.[75]

Is this intent being translated into action? To some extent, yes. Facilities in Europe and the Pacific generally are toned down or camouflaged, and many facilities are revetted. Critical support components, such as backup power generators and fuel tanks, are often protected by sandbags. However, there are currently *no* semihardened ATC facilities in Europe or the Pacific. Controllers at Kunsan AB, South Korea, expect to relocate to a semihardened operations shelter in 1991; however, the move is a byproduct of construction of a new wing operations center. Relocation of the

operations center vacated a semihardened building, which is being converted for use as an ATC radar facility.[76] Previous attempts to fund a dedicated semihardened radar operations center at Kunsan were unsuccessful, and funding would not have been available before 1994, if then.[77] A semihardened radar approach control (RAPCON) is also projected for construction at Osan AB, South Korea, in the mid-1990s, although funding is uncertain.[78]

The apparent lack of ATC integration into ABO planning may be attributable to a lack of mutual understanding. ABO planners may not fully recognize the wide variety of actions ATC controllers and facilities can provide in support of the four ABO objectives. At the same time, ATC managers may be guilty of parochialism. By thinking in terms of the ATC system rather than air base operability, they may fail to avail themselves of the support ABO planners could provide. The author's discussions with base-level ATC managers and ABO planners in South Korea support that theory and demonstrate that some mental barriers to effective integration still exist. For example, Kunsan controllers submitted a work order to enhance survivability of an alternate control tower. That work order was disapproved by the base civil engineers.[79] Such a proposal might conceivably have carried more weight had it been submitted under the ABO umbrella. Some ATC managers were also unaware of specific projects to enhance ATC survivability that were included in the base capability acquisition plan.[80] Effective two-way communication is vital to ensure ATC concerns are fully addressed in ABO planning.

Summary

The information provided in this chapter should leave the reader with a clear, if rudimentary, understanding of both the Air Force air traffic control system and the air base operability program. It should also convince the reader that there is a connection between the two and that ATC supports the four ABO pillars. The next chapter introduces operational factors crucial to building an ATC system responsive to wartime mission requirements. It discusses those operational factors individually and ties them back to ABO's defend, survive, recover, and generate objectives.

Notes

1. Joint Pub 1-02, *Department of Defense Dictionary of Military and Associated Terms* 1 December 1989, 22.

2. Linda G. Miller and Cora J. Holt, *Window to the Future: AFCC Chronology 1938–1988* (Scott AFB, Ill.: Office of AFCC History, n.d.), 7.

3. Ibid., 9.

4. Ibid.

5. AFCC Pamphlet 210-1, *The Air Force Communications Command: 1938–1986, An Illustrated History*, n.d., 2–3.

6. Ibid., 3.
7. Miller and Holt, 11.
8. Ibid., 12.
9. Ibid.
10. Quoted in ibid.
11. Ibid., 14.
12. *World Book Encyclopedia*, 1990 ed., "Radar," 68–70.
13. Maj Thomas H. Buchanan, *The Tactical Air Control System: Its Evolution and Its Need for Battle Managers* (Maxwell AFB, Ala.: Air University Press, 1987), 4.
14. Ibid.
15. Ibid., 6–7.
16. AFCC Pamphlet 210-1, 48.
17. Sir Robert Watson-Watt, *The Pulse of Radar* (New York: Dial Press, 1959), 55–58.
18. J. Mac McClellan, "Transponder à la Mode S: The FAA Serves Up a New Squawk Box," *Flying*, June 1987, 22.
19. Unnumbered AFCC Pamphlet, October 1989, 13. Effective 1 November 1990, responsibility for base-level communications (including ATC) will transfer to the supported commands. Headquarters AFCC will maintain oversight of ATC functions, however. For consistency, the author refers throughout this paper to "AFCC controllers/ATC equipment."
20. McClellan, 22.
21. Ibid.
22. The AN/GPN-22 PAR, however, uses a single antenna that provides both azimuth and elevation information.
23. Joint Pub 1-02, 19.
24. *Encyclopedia Americana*, 1987 ed., "Air Traffic Control," 396.
25. AFCC Pamphlet 210-1, 70.
26. *Encyclopedia Americana*, "Air Traffic Control," 397.
27. Ibid.
28. *Collier's Encyclopedia*, 1985 ed., "Navigation," 242.
29. Controllers assigned to combat communications groups come from the same pool of enlisted and officer ATC resources as do controllers assigned to AFCC's fixed ATC facilities. Thus every controller has an equal "opportunity" to be assigned to a combat communications unit.
30. AFM 2-12, *Airspace Control in the Combat Zone*, 22 August 1988, para. 2-5m.
31. TSgt Fernando Serna, "Combat Controllers Head for the Office," *Airman*, January 1990, 24–28.
32. AFR 39-1 (C1), *Airman Classification*, 30 March 1988, "Combat Control Operator," A13-25.
33. Capt Charles R. Lee, 4th Combat Communications Group/Air Traffic Control, discussion with author at annual Pacific air traffic services conference, Hickam AFB, Hawaii, 22 February 1989.
34. AFM 2-7, *Tactical Air Force Operations—Tactical Air Control System (TACS)*, 2 February 1979, para. 3-15.
35. Headquarters USAF/XOORF to Headquarters USAF/XOXWD, letter, subject: Draft AFM 1-1, March 1989; 16 June 1989.
36. Col Richard O. Nordhaus, "ATC in the Combat Environment," outline for a May 1988 briefing presented to the MAJCOM deputy chiefs of staff for operations at Constant Vigil XX.
37. Ibid.
38. The author heard this classified briefing when it was presented to Pacific air traffic controllers during the February 1989 Pacific Air Traffic Services Conference. It was also presented to the PACAF deputy chief of staff for operations and his staff during that same time frame. Unfortunately, the OPR never had an opportunity to present the briefing in Europe. AFCC intelligence functions were absorbed by Headquarters MAC during 1990.

39. AFR 360-1, *Air Base Operability Planning and Operations*, 31 December 1986, atch 1 (Terms Explained: "Air Base Operability").

40. Tidal W. McCoy, "Task One: Air Base Operability," *Armed Forces Journal International*, September 1987, 54.

41. AFR 360-1, "Air Base Operability Management, Planning, and Operation," draft, 1 May 1989, para. 1-4.

42. John F. Kreis, *Air Warfare and Air Base Defense* (Washington, D.C.: Government Printing Office, 1988), chap. 1.

43. McCoy, 54.

44. John T. Correll, "Fighting Under Attack," *Air Force Magazine*, October 1988, 50.

45. Ibid.

46. McCoy, 54.

47. Ibid.

48. Lon Nordeen, "Air Base Survivability, A Threat to NATO Airpower," *National Defense*, September 1988, 32-33.

49. Quick Look Functional Management Inspection of Air Base Operability (PN 89-612), 21 February-19 October 1989.

50. Lt Col Benjamin C. Pittman, "The ABCs of ABO: A Doctrinal Approach to the Air Base Operability Problem," draft (Maxwell AFB, Ala.: Air University Press, n.d.), chap. 6.

51. Col Gary H. Silence, ABO briefing presented at Air Command and Staff College, 8 May 1990.

52. Ibid.

53. Ibid.

54. Ibid.

55. Quoted in Maj Gen George E. Ellis, "More Hands for Base Defense," *Air Force Magazine*, December 1988, 70.

56. Maj Gen George E. Ellis, interview in *Airman*, June 1988, 8.

57. Lt Col Joe Boyles and Capt Greg K. Mittelman, "Paradox of the Headless Horseman," *Airpower Journal* 3, no. 1 (Spring 1989): 32.

58. Ellis, "More Hands for Base Defense," 69-70.

59. Ibid.

60. Ibid.

61. Boyles and Mittelman, 32.

62. Derived from an old fighter pilot joke regarding the value of air superiority when enemy ground forces are overrunning the air base.

63. Message, 021300Z Mar 90, Headquarters USAF/XOO, subject: Assumption of Air Force ABO Program Lead by HQ TAC.

64. Capt Jay S. Thompson, Headquarters AFCC/DOXE bullet background paper, subject: Air Base Operability, 4 May 1989.

65. For example, ATC tower and radar restoral vehicle prototypes, which support the ABO recover and generate pillars, were to be tested extensively during Constant Demo. These systems are discussed in chapter 3.

66. Lt Col John D. Wilkinson, Headquarters PACAF/DOUP, interview with author, Hickam AFB, Hawaii, 5 March 1990.

67. Silence briefing.

68. Since base-level ABO officers tend to be captains (or possibly majors) with little or no previous ABO experience and virtually no ABO training other than what they learn on the job, they are sometimes hindered by a lack of credibility. This credibility gap can lead to conflicts with unit commanders and, at worst, to a lack of confidence from the wing commander.

69. Silence briefing.

70. Ibid.

71. Wilkinson interview.

72. Col Gary H. Silence, discussion with author, Maxwell AFB, Ala., 8 May 1990.

73. Capt Robert L. Humbertson, "ATCALS in a Combat Environment," briefing presented at AFCC's annual ATC conference, Scott AFB, Ill., 25 October 1989.

74. Headquarters USAF/XOORB briefing script, 14 February 1989 briefing to the air base operability general officer steering committee.

75. AFR 360-1 (draft), para. 5-7c.

76. USAF Air Traffic System Analysis Report, Kunsan AB, South Korea, 11–19 October 1988, 3–4.

77. Ibid.

78. Lt David M. Winters, 2146th Communications Group, interview with author, Osan AB, South Korea, 27 February 1990.

79. Capt Bonita A. Bates, 1982d Communications Squadron/AT, interview with author, Kunsan AB, South Korea, 1 March 1990.

80. The base capability acquisition plan is a document that rank orders ABO capabilities and is used by ABO managers at all levels when allocating resources.

Chapter 2

Operational Factors

Headquarters AFCC has developed an air traffic control and landing systems (ATCALS) road map that has been briefed extensively at levels up to and including the vice chief of staff of the Air Force.[1] That road map, along with other command documents and briefings, identifies a number of operational factors AFCC considers critical for maintaining an air traffic control system that supports air base operability goals. These factors can be grouped loosely in three categories, with the connecting thread in each being the objective. The first category includes big-picture issues that contribute to the theater commander in chief's (CINC) overall war-fighting ability. The second addresses operational factors that contribute to effective operation of a single base ATC system. The third category addresses nuts-and-bolts procedures that can be used to expedite combat launch or recovery at a base. Although distinctions between the operational factors tend to blur, and some factors fit into more than one category, the author assigned each where she believed it fit best. This chapter discusses those factors by category and considers constraints that currently limit ATC effectiveness as a force multiplier.

Theater Integration of Air Traffic Control

To support a theater CINC's war-fighting strategy fully, ATC resources must be integrated with theater war planning to ensure controllers and equipment will be available to satisfy mission requirements. The ATC system must also be integrated with both the tactical air control system and theaterwide base defense systems.

Integration with War Plans

ATC equipment and personnel resources must support theater requirements established in war plans. Concept plans (CONPLAN) and operation plans (OPLAN) are developed by unified and specified commanders in response to requirements established by the Joint Chiefs of Staff (JCS). CONPLANs merely provide an abbreviated concept of operations for a specific scenario and are sent to the chairman, JCS for final review and approval. The main criteria for approval are adequacy and feasibility. If those criteria are satisfied, detailed planning is not required, but copies of

the CONPLAN are forwarded to supporting commands (such as AFCC) for review.[2]

The planning process is more complicated for OPLANs because detailed planning must be done at all levels.[3] Upon receipt of an OPLAN, AFCC completes a detailed analysis of communications, data-automation, and ATC requirements that must be satisfied if the plan is executed. Planners work with functional managers to ensure personnel and equipment shortfalls will not constrain mission accomplishment.

For example, there are currently about 950 controllers tasked by OPLANs to augment overseas control towers and radar facilities, fill airspace management positions, act as liaisons at host-nation ATC facilities, and operate mobile ATC equipment at bare bases. These controllers are sourced from CONUS communications units (fixed units as well as combat communications units; active duty as well as Air National Guard units). Another 2,000 CONUS controllers are tasked against base-level assessments (BLA); that is, they are part of the minimum manning required for a CONUS base to accomplish its wartime mission.[4]

In very simple terms, planners are responsible for ensuring that the amount of ATC equipment tasked in war and contingency plans does not exceed the equipment available in the inventory. Likewise, the total of OPLAN-tasked controllers plus those assigned against BLA cannot exceed the total of authorized controllers. Either of these situations results in a shortfall, and ATC equipment or personnel may become a limiting factor for the supported commander.

Conversely, a pool of authorized controllers much larger than the BLA- and OPLAN-tasked requirements results in an excess of untasked (but deployable) controllers. That situation inevitably generates such questions as: If these "excess" controllers do not have a wartime mission, shouldn't their positions be civilianized? An affirmative response seems the obvious answer, but attempts to cut back the number of military controllers should not be pursued overzealously. Even though good resource management dictates that the two sides of the equation be as well balanced as possible, manpower fluctuations (in authorizations as well as BLA and OPLAN taskings) occur constantly. Balancing the equation could easily become a never-ending (and therefore unproductive) cycle.

The fluctuation problem is compounded by the fact that, since detailed advance planning is not done for CONPLANs, no one really knows what ATC assets would be required to support specific CONPLANs. Realistically, it is difficult to envision a scenario in which implementation of a CONPLAN would overtask available ATC assets—unless of course a major OPLAN had already been implemented. Unlikely, perhaps, but that possibility and the possibility of unexpectedly heavy casualties, coupled with the lengthy time required to train replacement controllers, suggest that maintaining a small percentage of "excess" deployable ATC assets may be smart.

Integration with Tactical Air Control System

The combat air traffic control system must be fully integrated with the tactical air control system. AFM 1-1, *Basic Aerospace Doctrine of the United States Air Force*, states that the air component commander (ACC) is usually the central authority for coordinating and integrating air defense and airspace control. For optimum results, the ACC must have an "effective network for command, control, communications, and intelligence."[5]

The structure the ACC uses to exercise control over forces is the tactical air control system. "The TACS is a network of command, control, and communications nodes which allows the ACC to employ his air assets at the proper time and place to meet the threat"[6] and which aids the safe return of those valuable assets to a friendly base to fight again. The TACS "is composed of control agencies and communications-electronics facilities which provide the means for centralized control and decentralized execution of combat operations."[7] Although there are various TACS configurations, the tactical air control center (TACC) is always the senior element, functioning as the tactical air force commander's planning, directing, controlling, and coordinating center for air operations.[8] Other TACS elements which may support the TACC include airspace control centers, control and reporting centers, control and reporting posts, forward air control posts, the airborne warning and control system, the airborne battlefield command and control center, and message processing centers. Interestingly, most discussions of the TACS ignore an important element—the tactical air traffic control element (TATCE). The TATCE is the military ATC facility responsible for terminal area airspace control.[9] It provides "both en route and terminal services for aircraft transitioning to and from the battle area" and should be in continuous contact with the TACC.[10] Since aircraft may need ATC support to safely launch, travel through the terminal area, and recover under adverse weather conditions, it is difficult to understand why so many discussions of the TACS ignore the TATCE.

One obstacle to a smooth TACS/ATC interface is a widespread perception that the two systems are totally separate. Many air traffic controllers do not think of themselves as part of the TACS, nor do weapons controllers consider air traffic controllers part of the TACS. Because the two missions seem entirely different, relations between the two groups can be generally characterized as "us versus them." The conventional thinking is: air traffic controllers keep aircraft apart and weapons controllers bring them together. There is an element of truth in this idea, but it is an entirely too simplistic view of the complex airspace control system.

All the TACS elements (including the TATCE) must integrate to make up the theater airspace control system. These facilities should be "interfaced and linked with communications to form [a system that provides] safe, efficient use of airspace throughout the combat zone, while permitting maximum flexibility in the employment of weapons."[11] The easiest way to

visualize the relationship is to think of airspace control as composed of two separate but complementary types of service. As explained previously, ATC service provides for launch and recovery of aircraft, separation from obstructions and other known airborne traffic, and control instructions to reach a destination or transfer of control point. Tactical control service is also an airspace control service and, like ATC service, is provided by "radar and nonradar military air, land, and sea facilities."[12] The key difference is that tactical control service supports "aircrews [during] the mission or execution phase of flight," providing such services as intercepts, vectors for aerial refueling, and flight following.[13]

Although weapons controllers may direct an aircraft toward a target and can provide assistance to keep aircraft away from obstructions or other airborne traffic,[14] they "*may not* provide separation through the application of instrument flight rules" (emphasis added).[15] That is a very subtle distinction, but it is important. Military air traffic controllers are certified by the FAA to provide separation in accordance with established traffic separation criteria; weapons controllers are not.

Within the past three years, most AFCC senior leaders have recognized that in wartime ATC will be an integral part of the TACS. More and more midlevel managers are also accepting the challenge to "think war" and are focusing on the process of interfacing with other elements of the airspace control system. However, there are still pockets of resistance. Some ATC managers (at all levels) still believe air traffic controllers have no TACS mission and should not search for one,[16] but recent doctrinal changes clearly depicting ATC facilities as the tactical air traffic control element of the TACS in wartime make denying the relationship more difficult.

Attitudes are changing within the air traffic community as the education effort continues. Recent ATC conferences in Europe and the Pacific adopted "The Wartime Mission of ATC" as a conference theme, and AFCC briefings have also "spread the word." During exercises ATC personnel are now regularly assigned side by side with weapons controllers in the TACC's airspace control center.[17] Midlevel ATC officers and NCOs are now routinely sent to the airspace management and joint combat airspace command and control courses. There is a growing awareness throughout the ATC community concerning the role of a TATCE, and Air Force Communications Command is preparing its ATC managers to meet their wartime responsibilities.

A parallel education effort within the TACS community is not evident, however. Weapons controllers questioned by the author (while admittedly a small sample) did not consider ATC facilities part of the tactical air control system—in peacetime or in wartime. Some were not familiar with the term TATCE, and others disputed the TATCE's wartime role in the TACS.

This difference in attitudes is reflected in a distinct difference between doctrine and practice. In the Republic of Korea, for example, there is no direct contact between ATC facilities and the TACS. An F-16 taking off from Osan AB departs under the control of Osan Approach Control, but is only

required to remain under radar control until established on a departure route and in visual conditions. The pilot then cancels the instrument flight rules clearance and proceeds under visual flight rules. After leaving the ATC radio frequency, the pilot contacts the weapons controller who will handle the mission. The weapons controller identifies the aircraft and provides control instructions for the combat mission. When the mission is complete, the pilot heads back to base, contacting the Osan ATC facilities along the way for recovery instructions. There is no contact between air traffic controllers and weapons controllers during this scenario. In fact, such contact could be difficult because there is no direct landline linking the facilities; communications must be established by dialing a phone number for the other facility.[18] Should those air traffic and weapons controllers talk to each other on a routine basis? Perhaps not, since the Korean system works well in peacetime, and a strong argument can be made for not "fixing it." However, an equally strong argument can be made for practicing the way we will fight. If we believe that we will fight in accordance with our doctrine and that in wartime the TATCE will function as a part of the TACS, it would seem reasonable to, at a minimum, integrate air traffic control facilities into the TACS during exercises. There is no such integration now. Even during the annual joint/combined Team Spirit exercise, the ATC system remains totally separate from the TACS.

Another unfortunate by-product of the historic lack of communication between TACS and ATC managers is that there has been no effort to develop interoperable equipment. Each function conducts equipment procurement independently with little thought to system integration. As a result, radar data fed into ATC and into TACS facilities are not compatible. This incompatibility is not surprising since operator presentation requirements are different; however, it should be technologically feasible to develop a radar system capable of providing radar data to satisfy operational requirements of both air traffic controllers and weapons controllers. Such a system would allow automated (totally nonverbal) transfers of aircraft between ATC and TACS facilities.

Integration with Base Defense

The ATC system must also integrate, on a theaterwide basis, with the point air defense (PAD) and short-range air defense (SHORAD) elements of base defense.[19] This integration is vital "to ensure the smooth transition of missions through combat airspace, and to ensure proper identification of [recovering] aircraft."[20] Fratricide is a very real threat for aircraft returning to base in a combat environment The danger multiplies for battle-damaged aircraft, particularly if their radios or air traffic control radar beacon system transponders are out of commission. An effective integration of the ATC and base air defense systems, combined with established safe-passage corridors and aircraft surge, launch, and recovery

(ASLAR) tracks, would allow wounded aircraft the best opportunity to recover safely.

In selected European radar facilities, air traffic controllers man a SHORAD position, passing along information on unidentified inbound targets. Similarly, a Pacific initiative assigns security police to monitor designated radar scopes in the Osan and Kunsan RAPCONs.[21] These individuals receive information from the TACS as well as the radar approach controllers concerning possibly hostile inbound aircraft. Once an aircraft is identified as unfriendly, the liaison passes the appropriate location and course information to Stinger teams protecting the base. These systems are designed to allow weapons controllers, air traffic controllers, and air base defenders to act as a team in sorting out the friendlies—in the air rather than on the ground.

A recent real-world example of how such an integration can work occurred during the 1989 attempted coup d'état in the Republic of the Philippines. When rebel forces began fighting in Manila, the Aquino government requested support from US fighter aircraft based at Clark AB. The Clark ATC facilities immediately implemented "make-shift air defense reporting procedures," established a secure landline link to the air operations center, and designated a spare airport surveillance radar indicator as an air defense operations position. Over the next five days, controllers provided position reports and intercept headings on more than 50 unidentified aircraft for helicopters guarding the base perimeter. On 10 occasions, controllers vectored combat air patrol aircraft to intercept possible hostile aircraft.[22]

To complement a defense against an airborne threat, controllers should also be prepared to assist with ground defense. Experts in Soviet warfighting doctrine predict that an air operation against one of our air bases would probably include attacks by special purpose forces (*Spetsnaz*), as well as airborne or amphibious forces, and targets would most likely include radars and communications nodes.[23] ATC facilities may well be targeted. Although Air Force security police are responsible for providing defense of the base, they will have their hands full protecting the base perimeter and may not be able to guarantee the security of individual facilities against ground attack.[24] Controllers and maintenance technicians must be trained to observe enemy movements and defend ATC facilities. Actually, controllers on duty in a control tower are exceptionally well positioned to detect enemy movements, given their vantage point above the airfield. Binoculars are already standard equipment in all control towers, and Headquarters AFCC ABO planners have suggested that overseas towers also be equipped with night-vision goggles.[25] During a recent exercise at Kunsan AB, controllers and maintenance technicians were trained, armed, and given responsibility for defending the ATC facilities.[26] They successfully accomplished that mission.

Base-Level Air Traffic Control System

To be an effective force multiplier in wartime, a base-level ATC system must support operations in a variety of environments, survive, support surge operations, and communicate with all friendly aircraft. The system must also be operated by a well-trained, well-prepared controller force.

Operations in All Environments

Pilots must have confidence that whenever they need to launch or recover, the ATC system will be available and fully functional. We would prefer to fight at a time and under conditions of our choosing, but an enemy is unlikely to allow us that luxury. It may become necessary to launch or recover aircraft during bad weather or while the air base is under conventional, electronic, or chemical attack. ATC systems therefore must be able to support 24-hour operations in all weather conditions, while under enemy attack, and in an active electronic or chemical warfare environment.[27]

Weather. Since the latest generation of aircraft can fight around the clock in virtually all weather conditions, they must be able to launch and recover in all weather conditions.[28] Procedural and technical changes have significantly enhanced the ability of air traffic controllers to provide support during even the worst weather. For example, aircraft surge launch and recovery procedures (discussed later in this chapter) allow quick recovery of aircraft under adverse weather conditions. On the technical side, newer surveillance and precision radar systems are significantly more reliable than their predecessors. A long-standing pilot complaint has been: "Whenever the weather is bad and we really need the precision approach radar, it's off the air. PAR works fine when the weather is good and we can land without it." Technical advances during the past decade have done a lot to correct this problem. There appears to be no correlation between PAR outages and weather conditions (although outages certainly garner more attention when the weather is bad). In fact, AFCC statistics show that the latest-generation PARs have an average commandwide reliability rate of approximately 94 percent.[29] Unfortunately, those statistics have not yet translated into pilot confidence. Many pilots still believe PAR is unreliable.[30]

Under Attack. Ability to provide ATC service while under attack has been at least partially addressed through efforts to protect ATC equipment, to identify alternate ATC facilities, and to hone controllers' nonradar control abilities. Hardening, revetting, and camouflage have received a great deal of attention since 1985's Salty Demo exercise; many facilities in Europe and the Pacific are now camouflaged and some are revetted. Olive drab and sand beige tones have replaced the old red-and-white checkerboard paint that highlighted such lucrative targets as control towers, antennas, and navigational aids. Earth-filled revetments now surround such key facilities as the Osan and Kunsan radar approach controls. However, since radar

and radio antennas, TACANs, and ILSs cannot be adequately protected without disrupting their signals, the ATC system remains extremely fragile.

As for alternate facilities, most overseas wing commanders require chiefs of air traffic control operations to identify alternate ATC facilities. For example, it is common to use a runway monitoring unit (RMU) as an alternate when the control tower is off the air.[31] This alternative works well during peacetime control tower outages and would be a workable solution after an air base attack—if the RMU survives the attack. During an attack a more rational option would be to terminate control tower operations, transfer ATC responsibility to the radar facility, and let the tower controllers take shelter. Since AFCC does not expect control towers to survive an attack, it makes little sense to sacrifice the controllers, too. Although it is conceivable that aircraft caught unprotected on the ground would launch for survival during an airfield attack, they would not likely wait for a tower takeoff clearance. ATC support needed after they are airborne can be provided by the radar facility. Finally, even though radar antennas will probably be turned off during an attack to prevent enemy missiles from homing on them, radar approach controllers can still provide ATC assistance through nonradar approach control procedures. When controllers cannot see targets on a radar scope, they separate traffic using lateral and vertical separation standards. Nonradar control ensures safety but also increases separation between individual aircraft; as a result, traffic flow is significantly reduced. Radar controllers accomplish monthly nonradar training to maintain proficiency in these complex procedures.

Electronic Combat. Ability to operate in an electronic combat environment is also an important factor in maintaining a viable wartime ATC system. ATC radar and radios are particularly vulnerable to such enemy electronic countermeasures (ECM) as jamming. Controllers apply electronic counter-countermeasures (ECCM) to neutralize the effects of jamming and thus maintain command and control capability. The key to successful ECCM is recognizing when ATC systems or components are affected (either through direct targeting or inadvertently because of proximity to targeted systems). Initial and annual electronic combat training alerts controllers to the potential threat, trains them to recognize ECM symptoms, and "provides the skills and knowledge . . . to ensure electromagnetically dependent systems continue to operate successfully in a hostile electronic environment."[32]

In addition, hardware upgrades and procedural techniques can be used to minimize the effects of enemy jamming. For example, an extensive ECCM upgrade of the Berlin ATC radar facilities significantly reduced enemy ability to disrupt ATC operations through the Berlin corridor. Antijam radios are another effective ECCM tool. Have Quick radios "use a frequency-hopping technique [to] prevent enemy jammers from locking on and jamming . . . communications frequenc[ies]."[33] Have Quick radios are currently installed only in the Berlin ATC facilities. Although supported MAJCOMs have established requirements for Have Quick radios to be installed in other

ATC facilities (both overseas and in CONUS), the concept for their employment is not well defined. Funding issues, frequency availability, and signal source questions will also have to be resolved before Have Quick radios can be effectively used in ATC facilities.[34]

On the procedural side controllers can reduce the effectiveness of radar jamming by using filters and such radar features as the moving target indicator. Although there is little doubt well-trained controllers can reduce the effects of enemy jamming, ATC hardware remains a limiting factor. With the exception of those in Berlin, ATC systems are not adequately protected against sophisticated jamming attempts. A sustained and determined enemy effort would undoubtedly disrupt ATC operations somewhat—probably extensively.

Chemical Warfare. The ability to function in a chemical warfare (CW) environment is also a critical wartime requirement. Controllers have long had a problem communicating with pilots in this environment. The old M-17A CW mask, which controllers have to don whenever there is a threat of chemical attack, has limited visibility and no communications interface. Therefore, Headquarters AFCC exempted controllers from wearing it during exercises and inspections. That solution left controllers poorly prepared for operations in a real CW environment. A "temporary" fix, which added a communications interface to the M-17A mask, was fielded in the early 1980s. While not fully satisfactory, it proved better than the alternative and is still in use at some locations today.

The next-generation CW mask (the MCU-2P) provides better visibility but is also less than satisfactory because, again, it has no integral communications interface. A new version of the mask (the MCU-2P/I), which contains an intercom, is now being fielded. Controllers receive a high on-base priority for the new masks, which are already in use at a number of overseas bases. Unfortunately, even the new comm-modified version of the MCU-2P does not solve the controllers' problems. Problems with the newest mask include difficulty maintaining a seal when an ATC communications headset is being used.

Survivability

ATC equipment and personnel must be able to survive and to continue operations with a minimum of disruption.[35] AFCC assumes the main threat to ATC facilities will be from collateral damage, but that threat will be deadly.[36] "Few ATC [components] are hardened or otherwise protected. . . . Substantial collateral damage will be suffered due to their exposure, proximity to the runway, and lack of protection."[37] Several elements of the fixed ATC system (i.e., the primary control tower and the instrument landing system) are not likely to survive an airfield attack.[38] Vital support equipment (e.g., generators, fuel tanks, and air conditioners) is also vulnerable, as are radio antennas, which are often located away from the runway but close to other high-value targets.

Steps can be taken to provide protection for this equipment. For example, at Osan AB controllers place sandbags around generators, fuel tanks, and air conditioners. Camouflage netting is used along the outside of the RAPCON to break up the building outline. Another initiative the Osan controllers developed in coordination with base ABO planners is to tow the alternate tower facility (the runway monitoring unit) to a protected location when an attack appears imminent. A decoy RMU is placed at the opposite end of the airfield to draw fire.

A limited complement of mobile equipment is also available in Europe and the Pacific for quick wartime restoral of ATC capability. However, much of that equipment is nearing the end of its useful life. A number of programs are under way to field replacement systems, but they are threatened by potential funding cuts due to a lack of support from the war-fighting CINCs.

This lack of support derives from a line of reasoning called the airframes-versus-all-else argument. The argument proceeds along the lines: "If we fund a replacement radar/navigational aid system, less money will be available to procure new aircraft. Since we'd have to trade aircraft for support equipment, we can make do with the support equipment we already have in the inventory." To some extent, this is a reasonable argument, but it loses credibility if aircraft losses would be incurred that more survivable support equipment could prevent. Is this the case today? The answer, of course, is a judgment call, but clearly much of the ATC equipment in the inventory is aging and fragile, has already been extensively modified, and is far less capable than the state of the art can produce. The bottom line is that senior leaders must carefully analyze the cost-to-benefit equation before cutting dollars for support equipment modernization projects. (Equipment issues are addressed more extensively in the next chapter.)

Surge Traffic

ATC facilities and personnel must be capable of supporting surge traffic. AFCC expects combat recovery rates to be more than double normal peacetime rates.[39] Recent experience in Panama during Operation Just Cause indicates this estimate may be on the conservative side. Howard AB controllers worked more than 5,500 operations during the first three days of Just Cause. A "typical" Howard AB traffic count is on the order of 7,000 operations *per month*.[40]

Aircraft surge launch and recovery procedures are the tools developed to ensure controllers can support surge traffic. Simply put, ASLAR is a set of pilot and controller procedures designed to maximize aircraft launch and recovery rates. By creating a predictable environment, aircraft separation standards can be reduced by half. Thus, "aircraft can be put closer together, and the controllers can [effectively] control . . . more aircraft." ASLAR was developed to overcome a long-standing problem: The military "ATC system, using FAA procedures, . . . was incapable of recovering a large number of aircraft in a short period of time."[41]

In 1979 a task group composed of pilots and controllers began to study existing recovery procedures with the goal of increasing airfield recovery rates. Using live tests, demonstrations, and radar simulations, the task group developed and fine-tuned ASLAR procedures. Those procedures increased typical runway acceptance rates from 35 aircraft per hour to between 75 and 90 aircraft per hour when surveillance radar was operational.[42] Without surveillance radar, recovery rates increased from 15 to approximately 45 aircraft per hour.[43] Once the basic concept of ASLAR proved viable, ASLAR procedures were refined for theater- and base-specific needs. Major command headquarters then certified pilots and controllers at individual bases to conduct ASLAR operations and established requirements to maintain proficiency. The tactical air forces (TAF) exercised these concepts extensively, and ASLAR procedures are now in use throughout the TAF. Refinement of these procedures is a continuing process.

Even though bases usually set aside certain days or blocks of time for ASLAR training, a problem still exists in accomplishing effective training. The root of the problem is the need to provide expeditious air traffic service to ASLAR participants and nonparticipants alike. MAC, SAC, the sister services, and US allies do not use ASLAR procedures. Thus at a busy base with a complex air traffic mix, ASLAR nonparticipants often outnumber the participants. Since holding back nonparticipants until all the TAF fighters recover is usually not an option, the stream of ASLAR recoveries is quickly disrupted and tempers fray. An important point, however, is that nonparticipants will also be part of the terminal environment during wartime—probably in even greater numbers. If controllers and pilots do not practice integrating ASLAR participants and nonparticipants in peacetime, they will not be able to do it smoothly and safely in wartime.

One of the major criticisms of ASLAR is that the aircraft recovery tracks are too predictable. On the surface, that sounds like a valid concern. However, if a base is under or in imminent danger of attack, recovering aircraft would most probably be diverted to another location.[44] If the Air Force has air supremacy and the base is outside the enemy's ground-fire range, predictability of the approach course will not be a problem.[45] In fact, as discussed later in this chapter, such predictability is actually an operational advantage for the pilot.

Common Avionics

Available navigational aids (NAVAIDS) must be compatible with state-of-the-art avionics, allowing "maximum use of [sophisticated] on board avionics with minimum dependence on ground-based verbal ATC instructions."[46] At the same time, retention of older systems is necessary to allow all friendly aircraft access to the ATC system. Even within the Air Force, not all aircraft have the same avionics.[47] The problem is compounded when sister-service and allied aircraft are added to the traffic mix. As new ATC systems are added, old systems must be retained (often for a lengthy period)

to accommodate aircraft not yet retrofitted with the new avionics. A current example is retention of both precision approach radar and the newer instrument landing systems. Since some NATO and Pacific aircraft do not have ILS avionics, both PAR and ILS are likely to be retained for many years. This problem will worsen as microwave landing systems (MLS) enter the inventory.[48]

From a war-fighting perspective, system redundancy for precision approach can be a plus for more sophisticated aircraft. If an ILS were destroyed in an airfield attack, recovering aircraft with working radios would still be able to make a precision approach as long as the PAR remained operational. Conversely, if the PAR were destroyed, only ILS-equipped aircraft would be able to recover using a precision approach. If the weather were below nonprecision minimums, aircraft without ILS avionics would have to divert to an alternate airfield.

While redundancy of a precision approach capability is obviously an operational advantage, it has a distinct added cost in terms of personnel and logistics support. Since final controllers using PAR must individually control each approach and can only accept one aircraft at a time, PAR is a manpower intensive system. Although the senior operational commander at a base sets criteria for PAR availability, a standard rule of thumb is that one final controller will *always* be on duty, and a second will be available during periods when the wing is scheduled to fly. ILS approaches, on the other hand, do not even have to be monitored unless weather is below IFR minimums, and a single controller can monitor two ILS approaches simultaneously. On the logistics side, PARs and ILSs are dissimilar systems maintained by two separate groups of technicians. Different logistics support tails exist, and the costs of repairing and maintaining two different systems are higher. Although the tactical air forces have been a strong advocate for continued retention of PAR, the question of cost versus operational benefit will have to be answered repeatedly in today's era of fiscal constraints.

Well-Prepared, Well-Trained Controller Force

Pilots have a right to expect that the controllers who will support them in wartime will be meticulously trained professionals. Controllers must not only be well versed in FAA rules for sequencing and separating air traffic, they must also be trained (and proficient) in ASLAR, ECCM, and CW procedures. They must understand aircraft characteristics and capabilities and recognize constraints on pilots of single-seat aircraft. They must be able to work from austere mobile or alternate facilities. They must be able to think creatively when other than normal procedures are needed to assist aircraft attempting to launch or recover. Most importantly, controllers must have a war-fighting mind-set. They must be able to look beyond their

own narrow job descriptions and clearly focus on the "big picture"—air base operability.

As noted earlier, in some circles air traffic controllers have long had a reputation for having a peacetime mind-set. Some controllers do tend to think of themselves as FAA controllers in blue suits, do resist additional duties outside the ATC complex, and do expect the security police and base fire fighters to protect their facilities. Many fail to recognize that, under recent agreements with the Army, Air Force security police are responsible for providing local defense of the base and will concentrate their forces to guard the base perimeter. Likewise, the priority for the professional fire fighters will be crash-rescue. Structural fires—even those at key facilities—will be a secondary concern. Such considerations lead inescapably to Maj Gen George E. Ellis's conclusion that the Air Force needs multitalented warriors who can do their primary job and who are also trained in fire fighting as well as basic infantry skills.[49]

Procedures

An additional operational goal is to smooth aircraft launch and recovery and to minimize confusion in the traffic pattern. Although peacetime traffic separation standards are always desirable, reduced standards can (and should) be used when peacetime standards "are not sufficiently responsive to mission requirements."[50] Tactical air traffic control elements must not delay tactical missions because the missions lack standard peacetime separation, nor may TATCEs refuse to accept tactical traffic even when the system is saturated. In such cases, lower-priority traffic may be "denied access, diverted or delayed" so tactical missions can be supported.[51] Many of the operational enhancements discussed above help streamline the ATC system so that more aircraft can be serviced and as few as possible delayed or diverted. However, several procedural steps can also be taken to decrease terminal area confusion. These include building uncomplicated procedures, minimizing radio frequency congestion, and practicing unusual procedures.

Simplicity

ATC wartime procedures must be "uncomplicated, easily recognized, and as close to normal/peacetime procedures as they can be. The pilot should have confidence in them [and] in their ability to get him home."[52] Pilots returning from combat missions will most likely be exhausted and highly stressed. If their aircraft have been damaged, they will be running through emergency procedures and perhaps struggling to keep the aircraft airborne. The last thing pilots in such situations need is to have to decipher an unfamiliar approach plate, engage in lengthy conversations with controllers, or comply with unusual ATC instructions. Although the ground

situation (e.g., runway craters, aircraft in the barrier, etc.) may dictate out-of-the-ordinary maneuvers, the ATC goal should be to keep such maneuvers to a minimum. The KISS (keep it simple, stupid) dictum applies, and it should be a key consideration of ATC managers as they develop local ASLAR procedures.

Minimal Frequency Congestion

A closely related requirement is that radio frequency congestion be kept to a minimum. Radio chatter increases dramatically during a mass recovery, especially if some aircraft are returning to base battle damaged or low on fuel. Congestion is compounded if ATC communications are an ECM target. The synergistic effect can quickly bring on total confusion. Controllers can lessen that confusion by giving clear and concise instructions, using standard phraseology, avoiding extraneous questions, listening carefully to pilot transmissions, and using good frequency management techniques. Pilots can help by maintaining proper radio discipline, identifying emergency conditions promptly, stating their intentions clearly, and listening carefully to controller instructions.

Practice

A multitude of complex and unusual launch and recovery procedures will most likely be used in wartime. These include silent and mass launches as well as flush, ASLAR, and emergency procedures. These procedures must be practiced- often and realistically—in peacetime to identify and correct potential problems, to ensure all players are fully aware of their responsibilities, and to develop confidence that the procedures will be effective in wartime. A safe full of meticulously detailed contingency procedures that must be dusted off and executed extemporaneously serves little purpose.

Summary

All of the operational factors discussed above must be combined to create an efficient and responsive ATC system that functions as a force multiplier rather than as a force divider or limiter. These factors contribute to the defend, survive, and generate pillars of the ABO program, thus supporting the goal of ABO: combat sortie generation. But what of that fourth pillar—recovery? Continued generation of sorties may not be possible if damaged ATC equipment cannot be replaced or if an ATC capability cannot be restored. The following chapter deals with the equipment (that already in the inventory as well as programmed replacement systems) needed to ensure continuity of ATC operations.

Notes

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7. AFM 2-12, *Airspace Control in the Combat Zone*, 22 August 1988, para. 2-5.
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9. Ibid., para. 2-5i.
10. Col Richard O. Nordhaus, "ATC in the Combat Environment," briefing presented at Constant Vigil XX, May 1988.
11. AFM 2-12, para. 3-1.
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13. Ibid.
14. Maj Thomas H. Buchanan, *The Tactical Air Control System: Its Evolution and Its Need for Battle Managers* (Maxwell AFB, Ala.: Air University Press, 1987), 61–66.
15. AFM 2-12, atch 1.
16. Capt Richard F. Roberts, Headquarters AFCC/ATCO, bullet background paper, subject: Combat Airspace Control, 16 October 1987.
17. Ibid.
18. A work order for installation of a direct landline between the RAPCON and the TACC was submitted prior to the author's February 1990 TDY to South Korea; however, no action had been taken at that time.
19. Dorgan briefing.
20. Ibid.
21. The Korea program is known as Commando Spear.
22. Lt Col Kelly Cartron, 1961st CG/AT, point paper, subject: ATC Response to the 1989 Coup d'état, 4 January 1990.
23. Lt Col Price T. Bingham, "Fighting from the Air Base," *Airpower Journal*, Summer 1987, 34.
24. Maj Gen George E. Ellis, "More Hands for Base Defense," *Air Force Magazine*, December 1988, 69.
25. Maj John C. Goodman, Headquarters AFCC/DOXE, interview with author, Scott AFB, Ill., 23 October 1989.
26. Capt Bonita A. Bates, 1982d Communications Squadron/AT, interview with author, Kunsan AB, South Korea, 1 March 1990.
27. Dorgan briefing.
28. Nordhaus briefing.
29. MSgt Acey A. Olson, Headquarters AFCC/LGMM, telecon with author, 7 July 1990. Data provided is excerpted from the Communications-Electronics Status Reporting System data base. The figures (94.9 percent average reliability for the AN/FPN-62 and 93.9 percent average reliability for the AN/GPN-22) are derived from AFCC calculations which exclude equipment down time for scheduled or preventive maintenance. In the author's opinion, such an exclusion is appropriate because ATC equipment is not released for scheduled or preventive maintenance during bad weather.
30. The author's experience interviewing numerous pilots while assigned to the AFCC inspector general team overwhelmingly supports this theory.

31. RMUs were previously known as runway supervisory units.

32. AFCCR 50-2, *Electronic Combat*, 14 April 1989, paras. 1 and 6b.

33. "Electronic Combat," 1990 Air Command and Staff College handout, 53.

34. Maj Thomas Dorgan, Headquarters AFCC/ATTP, telephone interview with author, 5 July 1990.

35. Nordhaus briefing.

36. Ibid.

37. Capt Robert L. Humbertson, "ATCALS in a Combat Environment," briefing presented at AFCC's annual ATC conference, Scott AFB, Ill., 25 October 1989.

38. Nordhaus briefing.

39. Dorgan briefing.

40. "Operation Just Cause: 1978th's Air Traffic Controllers Pull Out All the Stops," AFCC *Intercom* (command newspaper), 16 February 1990, 2. Comparison provided from AFCC annual traffic count statistics.

41. Capt Ronnie P. Christiansen, "ASLAR—Do We Need It?" *Headquarters AFCC ABO Highlights Newsletter*, October 1989, 10.

42. Ibid., 11.

43. Ibid.

44. Ibid., 12.

45. Ibid.

46. Headquarters TAC/DOSB to the author, letter, subject: Tactical Air Command (TAC) Wartime Requirements for Air Traffic Control (ATC) Services, 19 January 1990, atch 1.

47. Nordhaus briefing.

48. Ibid.

49. Ellis, 69.

50. AFM 2-12, para. 3-3.

51. Ibid.

52. Nordhaus briefing.

Chapter 3

Equipment Factors

According to AFM 1-10, *Combat Support Doctrine*, "combat support is the art and science of creating and sustaining combat capability."[1] To apply aerospace power effectively in combat, such operational needs as those described in the previous chapter must be satisfied. Key to satisfying operational requirements is ensuring the proper equipment is in the inventory and available when and where it is needed. The air traffic control and landing systems road map mentioned previously identifies equipment AFCC considers critical to maintaining an ATC system that fully supports wartime mission requirements.

In general terms, each equipment element supports one of three basic ATC functions. Those functions are en route navigation and positioning, terminal radar control and sequencing, and precision landing.[2] This chapter analyzes each function in terms of the fixed equipment currently available to support mission requirements, mobile equipment available to support recovery efforts, and future equipment upgrades. A fourth section briefly addresses such support equipment as radios and generators which overlap individual functions, but which are also critical to continued sortie generation. The final section offers comments on a future (post-2000) systems concept that, if pursued, would dramatically change the character of military ATC.

En Route Navigation and Positioning

Currently, tactical air navigation systems are the primary military systems that enable pilots to navigate to an air base for recovery. A fixed TACAN is located at every Air Force base with an active flying mission. As with most navigational aids located near runways, TACANs are vulnerable to antiradiation missiles as well as to collateral damage from attacks on runways. For that reason, quick wartime restoral programs store mobile TACANs (AN/TRN-41s) at bases within designated high-threat areas in the Pacific and Europe. For example, two mobile TACANs maintained at Kunsan AB, Republic of Korea, are designated for use at Kunsan and Kwangju air bases. (Six wartime restoral TACANs are located in South Korea and others are located in Europe.) Sites have been presurveyed and flight checked so a mobile TACAN can be set up within 30 minutes and used immediately. A second type of mobile TACAN (the AN/TRN-26) is maintained by combat communications units and can be used to restore TACAN service at a fixed base or to provide initial service at a collocated operating

base or a bare base.[3] Although current TACANs have provided reliable service for the past three decades, they do have some limitations. TACANs are limited by line-of-sight coverage, short range, and vulnerability. Moreover, they do not provide worldwide coverage.[4]

When the NAVSTAR global positioning system (GPS) is fielded, it will provide precise worldwide en route and terminal navigation guidance. This space-based radio navigation system will provide three-dimensional positioning information accurate to within 16 meters. When fully fielded, the GPS will consist of 18 operational satellites backed by three on-orbit spares. Because it is a space-based system, GPS is generally considered highly survivable. It will also be jam resistant and able to accept an unlimited number of users. Most importantly, users will not have to emit a signal to receive GPS data.[5]

Although GPS is a quantum leap forward in capability, the Soviets have already demonstrated an ability to "kill" satellites in space, and ground-based control portions of the system may be vulnerable to sabotage. GPS will not be an invulnerable system, and TACANs will continue to provide a limited backup. Also, even if GPS is fully deployed by 1993, which appears unlikely given the current fiscal climate, it will not be universally usable until supported aircraft are equipped with GPS avionics. Although some USAF aircraft already have GPS receivers, the remainder of the fleet will not be upgraded before the end of the decade. Sister-service and allied aircraft may not be retrofitted even that quickly. Thus systems redundancy will remain critical, and TACANs will be needed well into the next century. Moreover, despite its extreme accuracy, GPS will provide only a non-precision approach capability. Precision approaches to a runway will still require a precision approach radar, an instrument landing system, or a microwave landing system. GPS therefore will not replace existing ATC systems but will augment and enhance them.

Terminal Area Control, Sequencing, and Separation

The second function ATC equipment supports is terminal area control, sequencing, and separation. These services are provided from the control tower and the radar facility.

Control Tower

Previous chapters established that, since the fixed control tower is probably not survivable, bases must identify alternate towers and develop alternate control procedures. As mentioned earlier, a runway monitoring unit is usually the first choice for an alternate tower since it is located close to the runway, provides good visibility of the runway, and has communications equipment (i.e., radios) already installed. However, because of its

location, the RMU is even more vulnerable to collateral damage than the fixed tower. Some bases protect RMUs by placing sandbags around them, embedding them in mounds of dirt, or towing them to protected locations during periods of high tension. Such tactics are unlikely to protect the RMU through more than one attack. Therefore secondary and tertiary tower alternates should also be identified.

At some locations a fire/crash tower may be a viable option and should be considered, but the most survivable option is also the simplest and cheapest. Controllers can provide service (i.e., aircraft sequencing, airfield advisories, and landing clearances) from any vehicle equipped with ground-to-air-to-ground (G-A-G) radios. Or, if radio-equipped vehicles are not available, controllers can operate from the back of a pickup truck using hand-held G-A-G radios. Such conditions are obviously not desirable for long-term operations, but ABO and ATC managers should consider these austere options as they look at means to recover from an airfield attack and to support resumed aircraft sortie generation.

Mobile Tower. If a fixed control tower cannot be readily restored after an attack and alternate facilities are not suitable for long-term operations, the senior operational commander on the base may request deployment of a mobile control tower. If assets are available, a combat communications unit will deploy with a mobile tower. Although these towers first entered the inventory in the late 1950s, they still provide a reliable and capable system that can be quickly set up and used in place of a damaged or destroyed tower for an extended period. However, most mobile control towers are located in CONUS. (There are five mobile control towers in the Pacific: three in Hawaii, one in Japan, and one in the Philippines.) A system would have to be airlifted either within theater or from CONUS to support a requirement in South Korea. This requirement will not pose a problem if airlift support is readily available. If airlift resources are constrained (which seems likely given the current and projected shortage of US strategic airlift capacity), a mobile tower may not be delivered for days. Since the Air Force has no quick tower restoral capability, controllers may have to work from marginally acceptable alternate facilities—for example, the bed of a pickup truck—for an extended period.

Interim Tower. A program has been in development for almost a decade to fill the interim capability gap by fielding "a small, shelterized tower mounted on a commercial utility cargo vehicle."[6] This system, known as a tower restoral vehicle (TRV), is intended to sustain operations until the fixed tower is repaired or a mobile control tower is deployed. It was envisioned as an austere, highly mobile system which could be stored at bases in high-threat areas to be rolled out and operating within 15 minutes after an airfield attack.

> The TRV will be used for interim restoral of tower ATC services at selected USAF tactical bases. This restoral capability [ensures] the ability to separate and sequence aircraft for launch and recovery operations. It will normally be prepositioned at theater air base locations to provide quick restoral of tower services after loss of primary assets

due to airfield attack or other event that has damaged or destroyed the primary ATC facility. The TRV is easily relocatable and capable of mobility over rough terrain, and set-up or tear-down in 15 minutes by three personnel. The mobility features allow the TRV to support a variety of USAF deployment options and secondary missions. These include control tower services in support of alternate landing areas such as off-base or alternate landing strips, airports, and roadways. The TRV's anti-jam radios ensure . . . capability to provide . . . service in hostile electronic combat environments. Secure communications are [also] provided [as are communications that allow] interface with PAD and SHORAD batteries and other ATC facilities.[7]

Although the TRV program has encountered numerous funding problems over the years, research and development continues. Two prototypes are being built and are slated to undergo operational testing in 1991. However, since no production money is currently programmed and since backing from some of the supported MAJCOMs is lukewarm, prospects for TRV production and deployment are uncertain.[8]

Radar Facility

Previous chapters established that, although radar antennas are susceptible to antiradiation missiles and collateral damage, radar controllers can continue to provide ATC service using nonradar procedures if they have functional radios and an operations center from which to work. Although a radar operations center is generally more survivable than a control tower, it is not invulnerable. Many overseas radar operations centers are revetted and camouflaged, and such critical mission support items as generators, fuel tanks, and air conditioners are sandbagged for protection. However, since no operations centers are currently semihardened, they are still vulnerable to collateral damage. With that in mind, ATC managers must identify alternate operations centers from which controllers can continue to provide sequencing and separation services.

Interestingly, the primary alternate for a RAPCON is often the control tower, which makes sense in peacetime. The tower is usually nearby, radios and landlines are already available, and only intra-squadron/group coordination is required. However, since the tower is not likely to survive an airfield attack, it makes little sense to depend on it as a RAPCON's primary backup during combat. Realistic secondary and tertiary alternates must be identified, and agreements for their temporary use must be coordinated in advance. Joint use of nearby radar facilities (TACS, sister service, civilian, or host nation) may be options and should be considered. If none of these are feasible, nonradar service may be the only option until a mobile radar system can be airlifted to the site.

Mobile Radar Approach Controls. Although nonradar service can be provided from virtually any building with G A-G radios, nonradar procedures reduce aircraft recovery rates by more than 50 percent.[9] Also, loss of radar "eyes" prevents effective integration with air defense forces and the TACS.[10] For these reasons, the base senior operational commander may be unwilling to rely on nonradar approach control service for an extended period. As with the control tower, the commander may request that one of

AFCC's combat communications units deploy a mobile RAPCON as soon as possible. If a system is available for use as a restoral asset (which is not a certainty by any means, since war plans identify most mobile RAPCONs for deployment to bare bases or collocated operating bases), the combat communications unit can be ready to deploy within a matter of hours. However, as with deployment of a mobile control tower, a limiting factor is airlift availability. Most mobile RAPCONs are based in CONUS or Hawaii and would have to be airlifted to wherever they are needed. Airlift is even more critical in this case, however, since a substantial amount of cargo space is required to airlift either of the two types of mobile RAPCONs currently in the Air Force inventory.

Although the author pledged not to become embroiled with detailed discussions of specific equipment, readers should understand some of the key differences between the two types of mobile RAPCONs. The AN/MPN-14 has been a mainstay of the ATC mobile equipment inventory for approximately three decades. It consists of three large equipment trailers crammed full of 1950s radar and radio equipment. Although the MPN-14 is road mobile (i.e., the trailers can be towed to a deployment location), most of the 25 operational systems are based in the United States and would have to be airlifted into a theater of operations. In its present configuration, each MPN-14 requires a C-5 for airlift. Numerous upgrades and modifications over the years have kept the system operating, but its logistics support costs have escalated, and Air Force Logistics Command recognized several years ago that the MPN-14 was on the verge of becoming unsupportable. Consequently, a sustainability modification was initiated in 1985 to replace the MPN-14's vacuum-tube components with solid state technology and to reduce the size of each system to two equipment trailers. The resulting MPN-14K will then be transportable in three C-130s. This modification was not intended to prolong use of the MPN-14 indefinitely, but rather to extend its life until a new mobile radar system could be fielded—hopefully within the 1990s.

The AN/TPN-19 is AFCC's second tactical radar system. It was fielded in the 1970s and, by virtue of its age, should be the more capable and reliable system, but this is not the case. The TPN-19 has been plagued by logistics problems and remains a maintenance intensive system. While the system is technically sophisticated in comparison to the aged MPN-14 and has actually performed well on recent deployments, many controllers perceive the TPN-19 as unreliable. Eight of the 10 TPN-19s are located in CONUS and are dependent on wide-body cargo aircraft for airlift.

AFCC initiated efforts to field a highly capable, state-of-the-art mobile radar system more than a decade ago. An earlier variant of this system (the T.PN-xx) was canceled in the mid-1980s because of lack of funding, but it has since been resurrected as the new mobile RAPCON (NMR). NMR will consist of an airport surveillance radar subsystem and an operations shelter subsystem with seven controller work stations. It will not include a precision approach radar, but it will have a PAR interface capability. A

PAR could thus be added to NMR if such future systems as the mobile microwave landing system (discussed later in this chapter) cannot be fielded.[11]

> [The NMR] will provide complete radar approach and departure control services to support launch and recovery operations in all weather and combat environments. The NMR is rapidly deployable and capable of being carried by C-130 aircraft. Once on site it can be fully operational in two hours vice current systems which take 12 to 24 hours. Its radar improvements will [use] state-of-the-art technology which is extremely reliable, featuring components that can be replaced within 30 minutes. Its radar has ECCM and ARM [anti-radiation missile] features and incorporates the use of anti-jam and secure radios—all of which are among the shortfalls in present systems. The NMR can also be pressurized against the chemical warfare threat.[12]

The NMR will also be more survivable than present systems. Use of fiber-optic communications lines between the radar and the operations shelter will allow the radar to be "remoted up to 12,000 feet from the [operations] shelter."[13] "The vastly improved radar . . . will allow operation through intense weather, ground clutter, and hostile jamming which currently restricts operations."[14] Although some might argue that sophisticated antijamming systems are not really necessary in ATC systems, the 1989 edition of *Soviet Military Power* states that Soviet planners continue to emphasize their integrated program to disrupt enemy military command, control, and communications at all levels.[15] ATC communications certainly fall in that category. In the face of such a hostile intent, efforts to protect against enemy jamming are only prudent.

Funding for the NMR has been cut significantly, and there is currently no production money programmed for the system. Unfortunately, NMR's reputation outside the ATC community is as a nice-to-have item. After all, MPN-14s and TPN-19s still work, and the Air Force is spending approximately four million dollars per system to modify 25 MPN-14s.[16] Some contend that there is, therefore, no need to spend hundreds of millions of dollars to buy 18 NMRs.[17] Others contend that NMR will be an operational and logistical bargain since it will save scarce Air Force resources over its life cycle. Reliability, maintainability, transportability, and survivability were all key in developing the NMR requirement (as well as that of the tower restoral vehicle and the surveillance restoral vehicle, which is discussed next). AFM 1-10 clearly points out that the Air Force has a responsibility to develop and acquire systems that support those four objectives and, as a result, conserve resources.

> Improving the reliability, maintainability, transportability, and survivability of new and existing aerospace systems is the pivotal path to reducing the combat support structure—manpower, materiel, and facilities—necessary to sustain combat operations. Therefore, the Air Force must give an unwavering emphasis to these vital areas throughout the acquisition process from requirements identification through concept development, design, production, and acceptance. This emphasis leads to enhanced combat capability by creating aerospace systems that consume less resources, which makes them easier to move and maintain in war.[18]

To summarize, Air Force mobile RAPCON capabilities currently include two systems that are wide-body airlift dependent, are slow to set up, and lack many of the features which would enable them to function effectively close to the modern battlefield. Tomorrow's system, the NMR, will be C-130 transportable, quick to set up, and include many of the features AFCC now considers essential to ensure continuous ATC service during combat. NMR production, however, remains unfunded and the system may never be built. If a restoral radar is needed in wartime, it may take days to deploy a mobile RAPCON and begin operations. As with control towers, an obvious capability gap exists from the time a fixed RAPCON is destroyed until radar service can be restored with a mobile RAPCON. Controllers can provide limited service in the meantime by using nonradar procedures, but that method is slow and cumbersome.

Interim Radar System. A surveillance restoral vehicle (SRV) is programmed to fill that interim radar capability gap. SRV is intended to "provide an immediate back-up radar capability" for the short term—until a fixed radar system can be repaired or a mobile radar system deployed. As with the tower restoral vehicle, prototypes are being built and operational testing is expected in 1991, but system production has not been funded. However, the requirement for a system to provide quick wartime restoral of radar capability is still valid.

> The mission of the SRV is . . . immediate interim restoral of ATC approach control services at selected USAF tactical bases. This restoral capability [provides] the radar capability to land and depart aircraft safely. Like the TRV, it will be prepositioned at theater locations to provide quick restoral services after loss of fixed assets. It's relocatable, capable of mobility over rough terrain, and is able to support operations of up to 30 days without preventive maintenance. The SRV is capable of set-up or tear-down within 30 minutes by three personnel. . . . The restoral capabilities of the SRV provide limited radar services through the use of a tactical . . . beacon radar, which [allows] service to transponder equipped aircraft. The radar is capable of detecting and interrogating 300 targets per scan. . . . A secondary role of this radar is that it can be integrated with PAD and SHORAD elements. As with the TRV, the SRV's radios ensure . . . capability for anti-jam communications with aircraft, ground forces, and other ATC facilities.[19]

Precision Landing

Precision landing capability is the third function that must be supported by capable, reliable ATC equipment. The only two precision landing systems currently in the military inventory are the instrument landing system and precision approach radar. Both have drawbacks. Although ILS is the newer system and is not dependent on communication between pilots and controllers, it can only be sited to provide guidance for a single runway and is not considered survivable in wartime. In fact, if emitting during an airfield attack, an ILS might enable enemy missiles to home in on the runway centerline, thus increasing damage to the runway. The PAR,

conversely, can be rotated to support approaches to several runways (within certain technical limits). However, since its antenna is located near the runway, it is also vulnerable to collateral damage. Another PAR limiting factor is that a pilot must be able to hear the controller's instructions (although it is not essential that the pilot be able to reply). Therefore, a successful PAR approach requires that, at a minimum, an ATC radio transmitter and an aircraft radio receiver be operational.

Although microwave landing systems are projected to replace both ILS and PAR, that technology continues to be delayed. In 1984 the FAA awarded a contract for 178 MLSs under a program sponsored jointly by the Department of Defense (DOD), the Department of Transportation (DOT), and the National Aeronautics and Space Administration (NASA). However, that contract was terminated in August 1989 when the program slipped to three years behind schedule. Congress has since directed the FAA to complete a nine-point demonstration program before awarding a new contract.[20]

A few MLSs are already operational (including one Air Force system at Shemya AFB, Alaska), and offer significant advantages over both PAR and ILS. For example, MLS allows pilots to fly steep, curved, segmented, or straight-in precision approaches. A single MLS can also support approaches to more than one runway. The operational advantages to a pilot returning from a combat mission are profound. By using a shorter, curving approach course or a steeper descent gradient, a pilot may be able to fly a precision approach to a runway where geographic features (e.g., mountains) previously precluded precision approaches. More importantly, the multiple MLS approach options allow recovering aircraft to vary their ground tracks, rendering them less vulnerable during the critical final phase of flight. Finally, new MLS approaches can be developed quickly, allowing pilots to fly precision approaches to a minimum operating strip after an airfield attack damages the primary runway. Neither PAR nor ILS offers such flexibility.

Despite these operational advantages, an MLS sited near the runway would still be a fragile system susceptible to collateral damage from runway attack. That shortcoming, however, can be alleviated by a little-known option: MLS can be offset from a runway it supports, reducing its vulnerability significantly. Although such an offset may not be necessary (or cost-effective) at CONUS bases, it should certainly be a siting consideration at overseas bases.[21]

MLS remains the heir apparent to PAR and ILS although current program status, fiscal constraints, and ongoing litigation apparently mean the system will not be fielded soon. Still, MLS is proven technology, and most senior ATC officials believe it *will* eventually replace both PAR and ILS. However, as alluded to in the last chapter, even when MLS is operational, ILS and PAR will have to be retained until all supported aircraft are retrofitted with MLS avionics. As with GPS, retrofitting is not likely to be completed until well into the next century.

To summarize, the Air Force's precision landing aid capability currently consists of two systems (PAR and ILS) that probably would not survive in a combat environment. The probable future system (MLS) will be more capable and somewhat more survivable, but it will not be available for an undetermined length of time.

This situation elicits the question: Do we really need precision landing capability in wartime? The answer is, only when the weather is below nonprecision landing minimums. An argument is sometimes made that aircraft will not be deployed when the weather is below those minimums. This argument is generally true for peacetime operations and exercise conditions, but it seems a dangerous assumption during wartime. The status of ground forces or availability of key targets might force aircraft to operate in bad weather on close-air-support or air interdiction missions. An enemy attack could force fighters airborne to provide defensive counterair support. Or, probably most likely, aircraft that depart during acceptable weather conditions could return to find the airfield (as well as all available alternates) below nonprecision landing minimums. Could the pilot land? Maybe, but the raison d' être for ATC service is to ensure that aircraft can take off, travel to their destination, return, and land in a safe, orderly, and expeditious manner. Gambling away an extra margin of safety by assuming that precision landing capability is not important because we will not fly when the weather is bad is shortsighted.

If one agrees that precision landing capability is vital and that current precision landing systems are not likely to survive an airfield attack, the obvious follow-up question is: What system will provide an interim precision landing capability until a mobile RAPCON (with PAR) can be deployed? Unfortunately, the answer is that there is no such system. The Air Force has no mobile ILSs and no mobile stand-alone PARs. Mobile microwave landing systems (MMLS) will fill the gap, but they will not be available for several years. MMLS is a joint Air Force, Army, and Marine Corps program initiated in 1984. An MMLS contract was awarded in 1988 and 33 systems will be delivered to the Air Force beginning in 1992.[22] MMLS will incorporate the technical advances of a fixed microwave landing system and will "provide . . . rapid set-up, highly transportable, flexible precision approach capability for . . . tactical/contingency sites."[23] Twenty-seven MMLSs are earmarked for basing in the Pacific and European theaters as quick wartime restoral assets and will fill today's interim precision landing aid gap.[24]

Support Equipment

Support equipment overlaps and ties together the basic ATC functions of en route navigation and positioning, terminal radar control and sequencing, and precision landing. Components can be categorized as either critical or noncritical.

Generators

Dependable backup generators are critical for both ATC facilities and navigational aids. Even a 20-second delay in radars and radios coming back on line after a power loss can jeopardize flight safety and fray a controller's nerves. Noninterruptible power sources are obviously preferable, especially in countries where the local power tends to be unstable. Unfortunately, noninterruptible systems in ATC facilities are rare. Inspector general inspections and air traffic system analyses frequently identify reliability of ATC and NAVAIDS generators as a problem. Although a base's 10-year plan usually covers generator replacement, generators are often much older before they are finally replaced or upgraded. ATC managers must alert such key individuals as the senior operational commander and the ABO planner to the long-term problems associated with backup generators.

Radios

There have long been arguments within both the ATC and operational communities over whether ATC facilities need Have Quick radios and secure voice capability. The case for Have Quick radios is reasonably cut and dried. This paper has already discussed the jamming threat to ATC radios and radars and established that a concerted enemy effort to jam ATC radar would most likely be successful. If that is the case and the weather is bad enough to prevent aircraft from recovering under visual flight rules, controllers would have to resort to nonradar control procedures. Functional radios are the minimum requirement for nonradar procedures. Thus simultaneous radar and radio jamming could prove disastrous. Under such circumstances, the antijam capability Have Quick radios provide would be critical to wartime readiness and would be a cheap investment. Unfortunately, as discussed in the previous chapter, this is an investment that probably will not be made in the near future.

With regard to secure voice capability, the jury is still out. Some believe that, to prevent enemy access to essential elements of friendly information, combat aircraft should operate in a secure mode from chock-to-chock. To do that, they would require secure radio communications with ATC facilities, and ATC facilities would require secure landlines to pass appropriate information concerning aircraft to other base agencies. If money were no object, it would be relatively easy to provide these capabilities. It *is* easy (and comparatively inexpensive) to install a STU-III secure telephone in a control tower or RAPCON. However, upgrading ATC facilities for truly secure communications would be an expensive proposition. Potential technical problems with the STU-III telephone increase the chances of a security compromise. For example, control tower windows are susceptible to electronic eavesdropping. Also, controllers operating with an open or "hot" microphone may inadvertently broadcast a nearby secure conversation over a nonsecure radio frequency. Such problems are not insurmount-

able; a combination of good security discipline and training, plus some technical fixes, could make ATC facilities secure. The real question is whether the benefits of secure voice in ATC facilities are commensurate with the costs that would be incurred. AFCC recently asked the MAJCOMs it supports that very question.[25] Although the responses varied considerably, the most common sentiment was that STU-III telephones are needed in ATC facilities, but secure ground-to-air-to-ground radios are not mission essential.[26]

Other Support Items

A number of other support items in the control tower and the RAPCON contribute to safe, expeditious ATC service. For example, airport terminal information service (ATIS) allows controllers to record and broadcast such information as weather, the runway in use, and airfield conditions over a designated radio frequency. By tuning in the ATIS broadcast before contacting a controller, pilots can reduce radio chatter in pilot-controller communications. Other tower and RAPCON equipment automatically print flight progress strips for aircraft landing, departing, or transiting ATC-controlled airspace. Loss of ATIS and automated flight progress strips would force controllers to accomplish those functions manually, thus slowing—but not halting—the flow of air traffic. Although such equipment items are certainly important (particularly during surge operations when work load is likely to increase exponentially), they are not *critical* components of a wartime ATC system and are not discussed further in this paper.

The Future

An advanced systems concept published by Air Force Systems Command's Electronic Systems Division in April 1988 offers a radically different approach to "military terminal area . . . ATC in the post-2000 time period."[27] The automated tactical aircraft launch and recovery system (ATALARS) concept was conceived as a way to enhance air traffic control survivability, interoperability, and flexibility in wartime. It assumes ATC will be provided in a hostile environment and neither current nor future ATC systems are likely to survive. ATALARS proposes eliminating "complex ATC systems at every [base] and replac[ing them] with an integrated aircraft based system and a single ground control unit for a large geographic area."[28] ATALARS is further described as a system that will provide

> airspace management, approach control, departure control, and landing functions via new techniques rather than conventional radar surveillance, voice communications, and centralized ground control now employed. ATALARS will use aircraft self-positioning, position reporting, automatic data link, and artificial intelligence based automatic data processing functions. Aircraft will make highly accurate position determinations on-board via navigation satellites. . . . This position location will be

conveyed by automatic data link . . . to ground control units and other aircraft. . . . Automatic data links will be used to convey service requests, general information, and specific control directions between a control unit and an aircraft. . . . Control units will consist of small, highly automated, low-cost mobile vehicles . . . capable of dispersed deployment. . . . ATALARS will [also] provide a high level of integration with other tactical air operations within the . . . theater. . . . interoperability with Army and Air Force base air defenses [and the potential for a] total battle management system.[29]

Although ATALARS is still in the conceptual phase, and funding constraints may preclude its ever becoming a reality, it is an intriguing concept. Its potential for increased interaction with air base defense and tactical air control units is especially appealing.

Summary

This chapter discussed ATC equipment that supports air base recovery and continued generation of combat sorties. Although most essential ATC equipment is already in place, there are also significant, worrisome gaps in capability. These gaps are likely to continue for the foreseeable future since not enough money is available to buy everything AFCC considers essential for an efficient and responsive wartime ATC system.

Some would argue the inability to purchase "everything" is not necessarily bad. The DOD biannual planning, programming, and budgeting system gives MAJCOMs an opportunity to rank order all programs, ensuring those considered "most dear" are funded. Thus the trade-offs made and calculated risks taken are necessary and important features of the system. There is much truth in that argument, and there is no reason why ATC programs should be exempted from the process. However, everyone concerned with the ATC role in air base operability (at a minimum, ABO planners, ATC managers, and pilots) must clearly understand the capabilities and limitations of the current ATC system, the operational benefits traded off as a result of program cuts, and the availability (or nonavailability) of interim or backup ATC systems. This chapter has attempted to contribute to that understanding.

Notes

1. AFM 1-10, *Combat Support Doctrine*, 1 April 1987, para. 1-4.
2. Maj Thomas Dorgan, "ATCALS Road Map," briefing presented at AFCC's annual ATC conference, Scott AFB, Ill., 25 October 1989.
3. A collocated operating base is an active allied base that can be used to bed down augmenting US forces.
4. Dorgan briefing.
5. Majors Steve Malutich and Bruce Thieman, "Space Systems for Military Use," 1990 Air Command and Staff College handout, 93–94.
6. Capt Robert L. Humbertson, "ATCALS in a Combat Environment," briefing presented at AFCC's annual ATC conference, Scott AFB, Ill., 25 October 1989.

7. Ibid.

8. Maj Thomas Dorgan, Headquarters AFCC/ATTP, telephone interview with author, 5 July 1990.

9. Humbertson briefing.

10. Ibid.

11. It now appears likely that the PAR portion of the AN/TPN-19 will be used with NMRs if the NMR is fielded.

12. Humbertson briefing.

13. Ibid.

14. Ibid.

15. Department of Defense, *Soviet Military Power: Prospects for Change, 1989* (Washington, D.C.: Government Printing Office, 1989), 53.

16. MSgt Dennis E. Rose, Headquarters AFCC/LGMKF, telephone interview with author, 9 July 1990.

17. The NMR program management directive states a requirement for 18 systems. However, recent changes in acquisition strategy call for NMR to be fielded as a TPN-19 replacement only. As a result, the requirement for NMRs will most likely drop to 10 or less.

18. AFM 1-10, para. 3-4.

19. Humbertson briefing.

20. William D. Conner, Headquarters AFCC/AT management summary, fixed base microwave landing system, 26 March 1990.

21. William D. Conner, Headquarters AFCC/ATTP, telephone interview with author, 13 April 1990.

22. William D. Conner, Headquarters AFCC/AT management summary, mobile microwave landing system, 26 March 1990.

23. William D. Conner, bullet background paper on mobile microwave landing system, 11 October 1989.

24. Ibid.

25. Message, 011600Z September 1989, Headquarters AFCC/XP, subject: Secure Voice Requirements for Air Traffic Control (ATC) Facilities.

26. Responses from the supported MAJCOMs are on file at Headquarters AFCC/XP and were reviewed by the author.

27. Capt Guy C. St Sauveur and Lt Melissa Greer, ESD/XT, "Automated Tactical Aircraft Launch and Recovery System (ATALARS)" (talking paper, Electronic Systems Division, n.d.).

28. Ibid.

29. Lt Guy C. St Sauveur and Peter W. Hughes, *Advanced Air Traffic Control Concept*, ESD-TR-86-259 (Hanscom AFB, Mass.: Electronic Systems Division, 19 June 1986), v.

Chapter 4

Recommendations

The preceding chapters clearly demonstrate that air traffic control is a combat support component of air base operability and plays a supporting role across the entire spectrum of ABO objectives. When effectively integrated into base ABO programs, the ATC complex (controllers and equipment) can help an air base defend against attack, survive an attack, recover, and resume generation of combat sorties. Although many recommendations are implicit in earlier chapters, this paper concludes by revisiting central issues and outlining some suggestions to strengthen the ATC-ABO link and enhance war-fighting capabilities within the ATC community.

The following recommendations are derived from observations made and conclusions reached during the course of this research. They are, of course, influenced by the author's personal beliefs and attitudes after 14 years of experience as an air traffic control officer. The recommendations are divided into three basic categories: system issues, people issues, and equipment issues. Some recommendations overlap categories.

System Issues

Some ATC managers do not fully understand air base operability or what types of support ABO planners can provide them. Tying ATC survivability initiatives into the base ABO program is a smart way to avoid duplication of effort and can result in stronger base-level support. Likewise, ABO planners should understand that ATC can contribute to the four primary pillars of air base operability. They need to know what controllers can do to help the base defend, survive, recover, and generate, and they should understand restoral options for ATC equipment.

Base-level communication is critical in developing this understanding. ATC managers must ensure they are represented at ABO working group meetings. But more than that, they must recognize (on a gut level) that supporting ABO objectives is a fundamental war-fighting responsibility and that ABO working group meetings are not just another of the myriad of base-level meetings to be attended. Selection of a well-qualified representative (rather than whoever has the least to do that day) to attend these meetings will ensure ATC concerns are aired at working group meetings and, if necessary, carried forward to the steering group.

As mentioned earlier, there is a major difference in the perceptions of the air traffic and weapons control communities regarding an ATC role in the tactical air control system. Although the air traffic community's internal education effort is yielding results, there appears to be no parallel effort within the weapons control community. Increased cooperation is occurring in a number of areas, but it stems from isolated initiatives rather than a widespread attitude change. Many weapons controllers (from the highest levels down) still do not believe that ATC is a wartime part of the TACS. ATC senior leadership should make a concerted effort to convince senior weapons controllers that ATC facilities play a vital role as the tactical air traffic control element of the TACS in wartime and that the inclusion of ATC in the system enhances overall airspace control services.

This paper has emphasized that controllers will have base defense responsibilities in wartime. ATC managers must think through possible ATC contributions to air defense in advance. Although the attempted coup in the Philippines demonstrated that air defense procedures can be implemented in response to a specific situation, it makes sense to consider the issues early, develop a plan, and then practice it. To do this effectively, a systems perspective is vital. Controllers, air defenders, and ABO planners must all recognize the capabilities and limitations of each air defense component as well as how the pieces fit together. The author's observations in South Korea were that, even though Stinger teams operated out of the RAPCONs, there was little real integration of ATC into air defense responsibilities. Many controllers believed the Stinger teams were just using an extra radar scope in the RAPCON and really did not have anything to do with ATC responsibilities. Letters of agreement for the operation reinforced that mind-set by focusing primarily on administrative details rather than the big picture. Controllers should be ready not only to provide warning of inbound hostile aircraft but also to defend ATC facilities. This is a new idea for many, and training to accommodate it must be done in peacetime. Since there is a very small reservoir of combat experience within the career field, and thus few role models, that training needs to be as realistic as possible to build confidence.[1]

War plan requirements for ATC assets must be as accurate as possible. As shown earlier, good resource management requires that available ATC resources balance closely with wartime requirements (i.e., OPLAN-tasked controllers plus those tasked against CONUS base-level assessments). Good initial planning is essential. If planners do not realize until day 7 of the war that they will need an additional 30 controllers to act as liaisons in host-nation ATC facilities, those assets may not be available for deployment. Since controllers need extensive initial training before they are usable (in any facility or any ATC position), increasing the number of trainees in the training pipeline after hostilities have begun is not an answer.

People Issues

A thread that has run through this narrative is the need to develop a war-fighting mind-set. Listening to young controllers, one sometimes gets the impression they believe pilots fly sorties to provide training for air traffic controllers. That is an interesting perspective, but it is not very realistic. Controllers at all levels must understand how they fit into the war-fighting puzzle, how they can function as a force multiplier, and how they can avoid acting as a force divider. The key is education. ATC managers must continually stress wartime mission requirements and set appropriate standards with tough, realistic training.

One way to build a war-fighting mind-set is through regular war-fighting brainstorming sessions. Equipment, procedures, and personnel change, and those changes may become the catalyst for a disaster if ATC managers do not stop to consider the implications. Such changes often seem trivial until they snowball into a major fiasco. Take, for example, the story of the tower controllers who could not get into their alternate facility (the RMU) because the key had been moved and no one in the tower knew where to find it. Brainstorming sessions can help prevent such embarrassments if staff members feel free to think creatively, exchange ideas openly, and discuss not only procedures but also backup plans to be used when things go wrong.

Another way to enhance a war-fighting mind-set is to take advantage of the expertise combat controllers possess. An earlier chapter mentioned that, with rare exceptions, there is virtually no contact between air traffic controllers and combat controllers after they complete technical school. It surely would be useful to create joint training opportunities to cross-flow combat controller expertise into the AFCC controller force.

Any concerted effort to enhance ATC integration into the TACS must involve the people who operate the systems. Of almost 400 air traffic control officer (16xx) positions Air Force-wide, none are located in TACS units. Likewise, no weapons control officers (17xx) are assigned to work in ATC facilities. Individual technical qualifications and job requirements obviously limit the utility of cross-utilization, but career broadening options at selected locations might prove beneficial to both individuals and the Air Force. ATC managers at all levels should aggressively seek exercise opportunities that allow ATC facilities to function as part of the TACS. Air traffic controllers need the experience, and weapons controllers need to see how ATC can augment and enhance their own capabilities.

Because controllers must be intimately familiar with aircraft operating characteristics, orientation flights can provide crucial training. Such flights encourage controllers to be more sensitive to cockpit pressures and increase their understanding of the effect of inappropriate tower or RAPCON actions (i.e., poor vectoring techniques, late turns to final approach, "roller coaster" precision approaches, excess verbiage, etc.) on an aircrew. It makes good

sense for flying units to use their few available orientation flights where there will be a direct payback to the flying mission.

Equipment Issues

As with most acquisition programs, quantity versus quality is always a concern with new ATC systems. Determining the "right" mix is difficult, but AFM 1-10 puts the issue into perspective:

> Air Force resources . . . require a balance between quality and quantity. More does not mean better. Greater quantities of resources do not necessarily lead to improved combat capability. The organization and quality of manpower, materiel, facilities, and information is equally as important. The aim is to get the most capability out of the existing force structure. However, quality is not a substitute for quantity. History demonstrates that high levels of attrition will occur in a protracted conflict between advanced industrial nations. Therefore, a force structure that relies exclusively on quality cannot prevail in the long run. Force "multipliers" become force "dividers" as they are lost to combat. . . . Both quantity and quality are important to all combat resources when engaged with an enemy who is capable of waging attrition warfare.[7]

Although this philosophy does not offer easy solutions, it does convey an attitude—balance—that should guide the actions of those involved with acquisition of new ATC systems.

Another problem that has plagued acquisition of new ATC systems over the years has been the difficulty of obtaining operator support for funding. Such systems as the new mobile radar approach control are routinely ranked low in the Air Force program objective memorandum because of inadequate support from the supported MAJCOMs. Efforts to educate senior operators on what ATC can do for them in a combat environment (and what they lose if their ATC system is not capable and survivable) are continuous and have had some success. However, the author's experience (both in the field and during this research project) indicates that many operators still fail to think of ATC as their concern. Their attitude seems to be: "If ATC is there in wartime, fine. If not, we'll fly and fight without it." Wise peacetime ATC investments should be thought of as insurance that the system will be in place and responsive when it is needed and the operators will not have to fly and fight without its advantages.

Difficulties in obtaining operator support for ATC acquisition and upgrade programs may be exacerbated by a lack of effective initial coordination. The process traditionally works as follows: AFCC asks the supported MAJCOMs what ATC capability they will need in wartime; the supported MAJCOMs are busy with their own alligators and either do not respond or provide comments too general to be useful; AFCC (as the functional expert) develops a statement of need, gets a program rolling, and then tries to convince the operators to support the program in the funding process; the supported MAJCOMs are appalled at the cost and insist they do not need the capability; AFCC, convinced that the program is vital, then proceeds to try to convince the supported MAJCOMs that they do in fact need the

Glossary

AACS	Army Airways Communications System
AB	air base
ABO	air base operability
ACC	air component commander
ACSC	Air Command and Staff College
AFB	Air Force base
AFCC	Air Force Communications Command
AFM	Air Force manual
AFR	Air Force regulation
ANG	Air National Guard
ARM	antiradiation missile
ASLAR	aircraft surge, launch, and recovery
ATA	airport traffic area
ATALARS	automated tactical aircraft launch and recovery system
ATC	air traffic control
ATCALS	air traffic control and landing system
ATIS	airport terminal information service
AUCADRE	Air University Center for Aerospace Doctrine, Research, and Education
BLA	base-level assessment
CATCO	chief of air traffic control operations
CINC	commander in chief
CONPLAN	concept plan
CONUS	continental United States
CW	chemical warfare
DOD	Department of Defense
DOT	Department of Transportation
ECCM	electronic counter-countermeasures

ECM	electronic countermeasures
FAA	Federal Aviation Administration
FMFM	Fleet Marine Force Manual
G-A-G	ground-to-air-to-ground
GCA	ground control approach
GPS	global positioning system (formerly NAVSTAR)
IFR	instrument flight rules
IG	inspector general
ILS	instrument landing system
JCS	[illegible] Chiefs of Staff
KISS	keep it simple, stupid
MAC	Military Airlift Command
MAJCOM	major command
MLS	microwave landing system
MMLS	mobile microwave landing system
NASA	National Aeronautics and Space Administration
NAVAIDS	navigational aids
NAVSTAR	Navigation Satellite Timing and Ranging (now GPS)
NMR	new mobile RAPCON
OPLAN	operation plan
PACAF	Pacific Air Forces
PAD	point air defense
PAR	precision approach radar
RAPCON	radar approach control
RMU	runway monitoring unit
SAC	Strategic Air Command
SHORAD	short-range air defense
SRV	surveillance restoral vehicle
TAC	Tactical Air Command
TACAN	tactical air navigation
TACC	tactical air control center

TACS	tactical air control system
TAF	tactical air forces
TATCE	tactical air traffic control element
TDY	temporary duty
TRV	tower restoral vehicle
UHF	ultrahigh frequency
USAF	United States Air Force
VFR	visual flight rules
VHF	very high frequency